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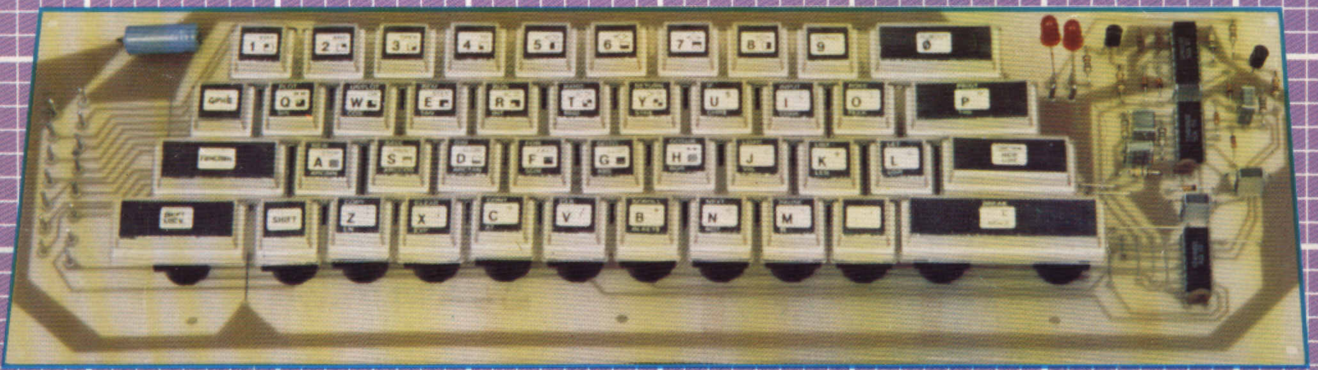
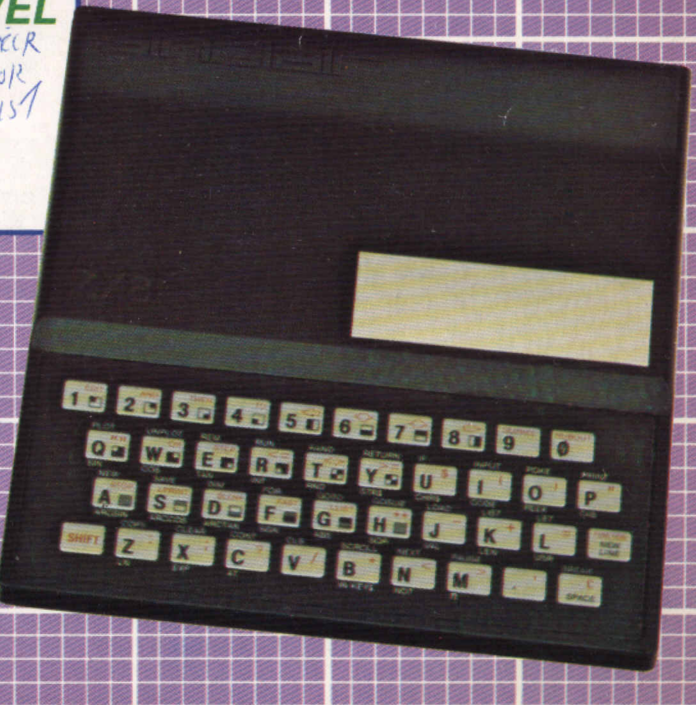
Electronics
THE MAPLIN MAGAZINE

JUNE 82 TO AUGUST 82 VOL 1 No. 3

SUPERB 25W PER CHANNEL RMS STEREO AMPLIFIER WITH RELIABLE MOSFET OUTPUT STAGE IS SO EASY TO BUILD



OUR ZX81 FULL SIZE, FULL TRAVEL KEYBOARD MAKES GRAPHICS, FUNCTION AND SHIFT LOCK SINGLE-KEY OPERATIONS FOR LESS THAN £20! CHECK BOOK LIST 22 LICENCE NOTE



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Detection range adjustable from 2m to over 20m

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Electronics
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INTEREST FREE CREDIT ON COMPUTER HARDWARE

In this issue we're pleased to announce details of an exciting new scheme. If you want to buy over £120-worth of computer hardware, we can now offer you nine months to pay — interest free! All you pay is 10% of the cash price when you collect the goods, then 10% a month for a further nine months. You end up having paid only what you'd have paid had you bought it cash, but with the payments spread over 9 months. Now you can afford today, the computer you always wanted, without having to pay crippling hire purchase charges. With our scheme there are no charges at all! At the present time we're planning to run the scheme until the end of August '82, but we will extend it if it is very successful.

Talking of success, we still can't believe how many subscriptions we've received for this magazine. Though I must apologise for disappointing you by having to hold over promised articles. Last time we didn't have space for the sequencer, so we've now published this as a leaflet (see page 5) and this time with much regret, we have to hold over the frequency counter, even though we are certain it will be very popular. Its unique digital switching system makes it unbelievably simple to use.

Finally, a plea to please keep your letters coming. In this issue we were able to print *every* letter received. Usually we are able to choose from about 50 or 60. It's hard to believe that we totally please our customers for every one of the 50,000-plus orders we despatch every quarter. So if you can think of ways we could improve our service then please do write. Even if we don't publish your letter, you can be sure that all the directors at Maplin read and take note of what you have to say. We may well not agree with what you say, but we're happy to throw open the discussion through these pages.

As usual, we're well-advanced with the projects for the next issue — some really interesting things too, as you'll see if you take a look at the inside rear cover. Many of the projects for issue 5 are also well-advanced and we're really excited about a unique new service we're hoping to launch with issue 5. The Maplin Magazine is always original and up-to-date. Don't miss it — send your subscription now!

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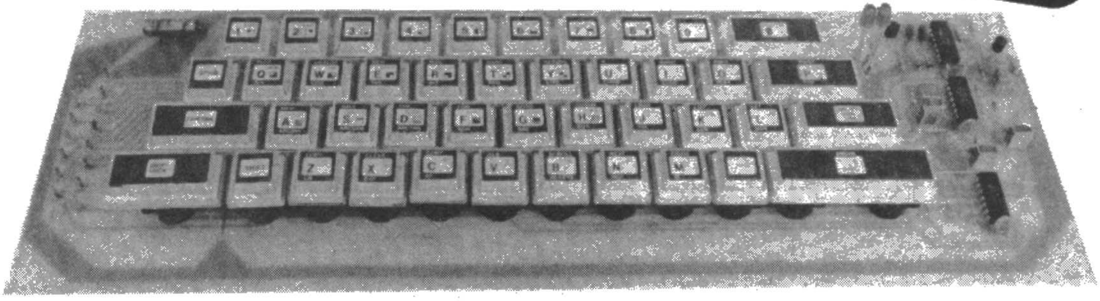
Published by Maplin Publications, 282 London Road, Westcliff-on-Sea, Essex SS0 7JG
Printed by Eden Fisher (Southend) Limited
Typeset by Quillset Typesetting
Distributed by Spotlight Magazine Distribution Limited, 1-11 Benwell Road, London N7

FULL~SIZE KEYBOARD

Complete kit ONLY £19.95 case extra

FOR ZX81 MICRO-COMPUTER

by Dave Goodman



- ★ **Single key selection of Graphic symbols, Function mode and Shift Lock**
- ★ **Full size, full travel, 43-key keyboard**
- ★ **Two-colour legend for keys is the same as the ZX81 keyboard**
- ★ **Faster, more reliable entry — use it once and you won't be able to do without it again!**

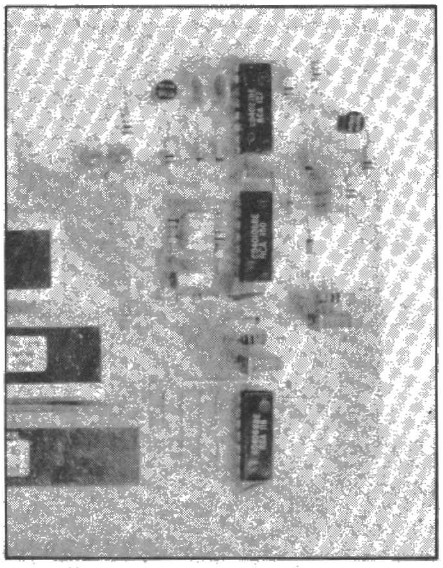
Support systems for the Sinclair ZX81 are very much in demand at the moment and an add-on keyboard with full size keys can offer a great improvement over the existing unit. Operation becomes more positive, unlike the ZX81's touch-keyboard where the only way to be sure you've pressed the key correctly is to check on the screen. With this keyboard, the feel is similar to that of a typewriter and thus entry speed is far higher and much more reliable.

On the ZX81's touch-keyboard, to select a graphic symbol — first the "shift" key must be operated and held and then the "graphics" key operated, then the "shift" key held and the actual graphic symbol required pressed. On this keyboard simply press and release the "graphics 2" key. An LED gives an indication that the mode is selected and the screen cursor changes to [G] as normal. Now any desired graphics symbol may be selected directly without pressing or holding any additional keys. Press and release "graphics 2" key again to return to normal mode. The LED will extinguish and the screen cursor will return to [K or L].

On the ZX81's touch-keyboard selecting a function requires a similar operation to selecting a graphics symbol. On this keyboard simply press and release the "function" key. The screen cursor changes to [F] and an LED flashes once to indicate that this mode is selected. Now any of the operator keys may be selected directly without pressing or holding any additional keys. After selection the LED is extinguished and the screen cursor returns automatically for normal entry.

Finally, this keyboard has a "shift lock" key that electronically holds the keyboard in shift mode after that key is momentarily pressed. A second LED lights to indicate that this mode is selected. Pressing the "shift lock" key again, extinguishes the LED and returns the keyboard to normal entry mode.

Our own experiments have proved that this keyboard is invaluable. No-one who tried it wanted to go back to using the touch-keyboard. Relief from neck-ache was one often cited advantage! Users described how with the touch-keyboard one looks down to the left or right to read the program to be entered, then at the keyboard to select the key, then up at the TV to check the symbol has gone in, then often, back to the keyboard to roll the finger around a little more because the symbol hasn't been entered (apparently a common occurrence), then up to the TV again, then back to the program. When entering with our keyboard, operators rarely needed to move at all.



Children who used it, found they could perform complicated operations easily — often they could not do the same thing on the touch-keyboard at all! Everyone agreed that there was no alternative on the market and almost lynched the author to get their hands on the prototype.

S1 = 1	S15 = R	S29 = J
S2 = 2	S16 = T	S30 = K
S3 = 3	S17 = Y	S31 = L
S4 = 4	S18 = U	S32 = New Line
S5 = 5	S19 = I	S33 = Shift Lock
S6 = 6	S20 = O	S34 = Shift
S7 = 7	S21 = P	S35 = Z
S8 = 8	S22 = Func'	S36 = X
S9 = 9	S23 = A	S37 = C
S10 = 0	S24 = S	S38 = V
S11 = Grps 2	S25 = D	S39 = B
S12 = Q	S26 = F	S40 = N
S13 = W	S27 = G	S41 = M
S14 = E	S28 = H	S42 = ·
		S43/44 = Space

Table 1. Key function chart.

Construction

Begin by straightening and forming the wire links of which there are thirty. These must be fitted first. Then fit the six diodes, taking care to align the black band printed around the body with the white line printed on the pcb. Insert all the resistors. For those unfamiliar with the colour code, a chart is printed in the resistor section of our catalogue or you can use the Colour Wheel (XL05F).

Next fit the three IC's taking care to ensure that they are the right way round and that all the pins come through the pcb. Polycarbonate capacitors are easily recognised by their silver bodies. They fit directly on to the pcb, but if the legs have been bent, take care when straightening as they are easily broken. Fit the four little disc ceramic capacitors and then the axial electrolytic. With this component ensure that the indent around the body of the capacitor is at the same end as the '+' sign printed on the pcb. Finally fit the two transistors so that their 'D' shaped package aligns with the 'D' shape printed on the pcb. Push them down to about 0.5 to 1cm (¼in) from the pcb surface.

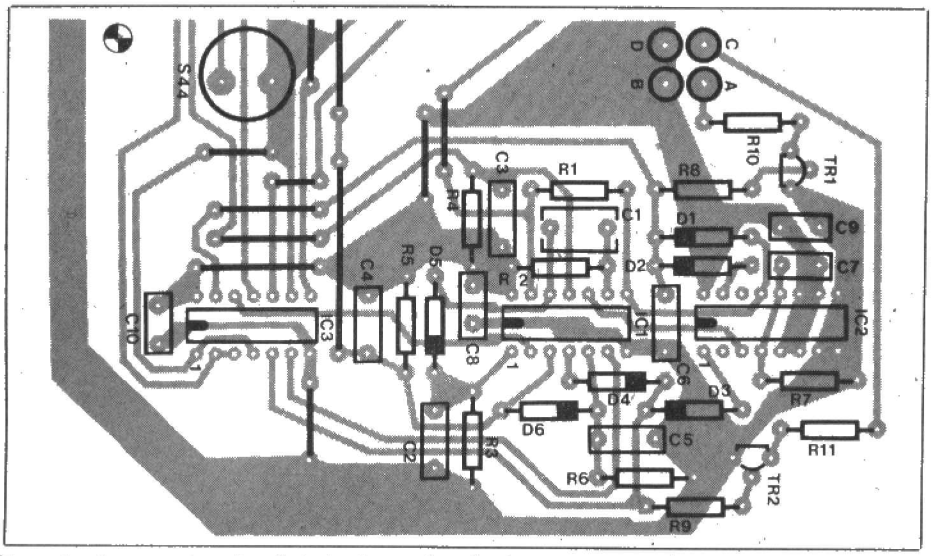


Figure 1. Component overlay of electronics section of pcb.

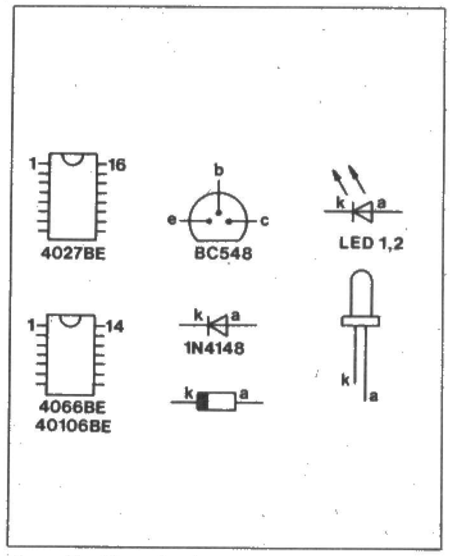


Figure 3. Pin-outs of components.

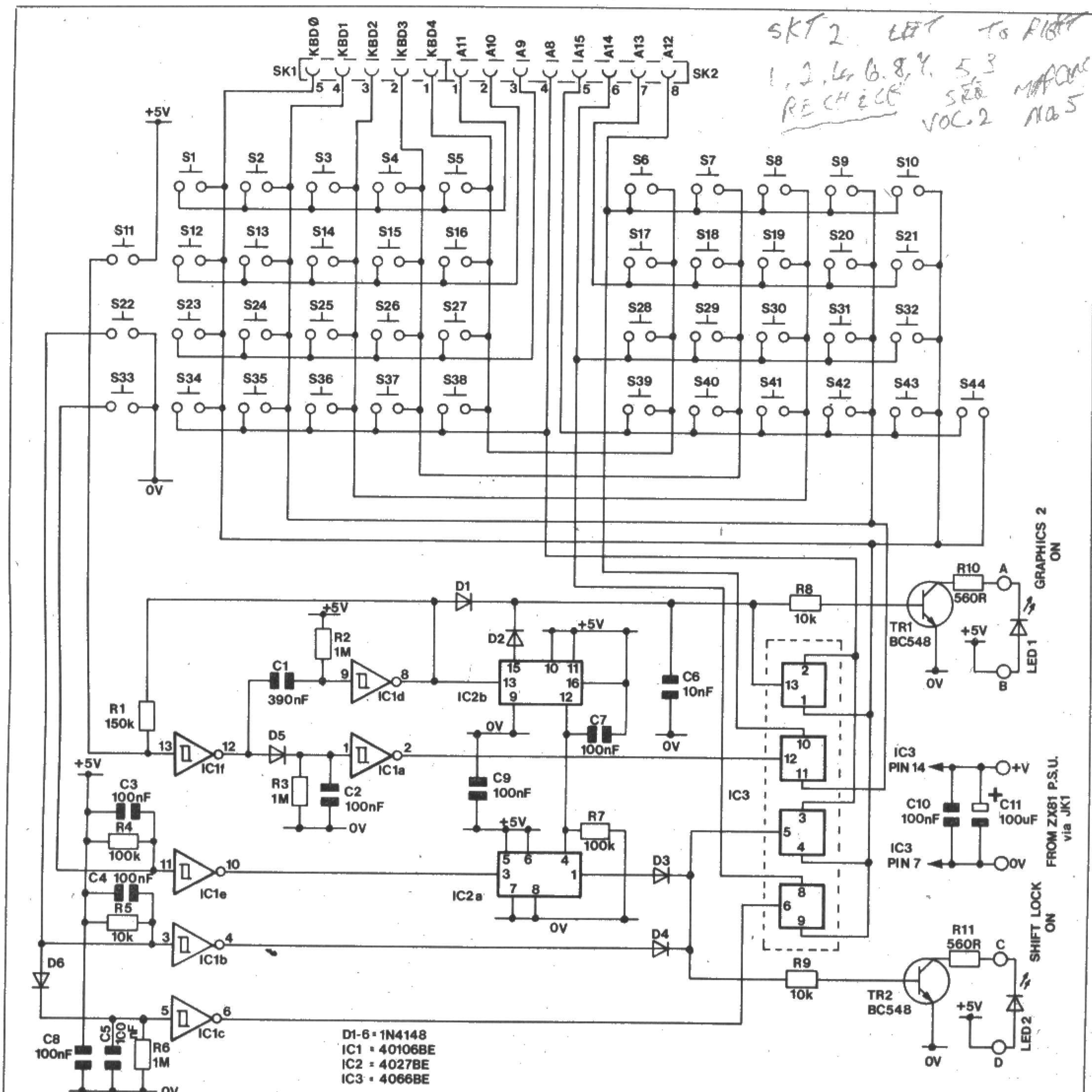


Figure 2. Circuit diagram.

ZX81 KEYBOARD

Carefully solder all the components and links inserted so far, then fit the 44 key-switches in position. Place a piece of stiff card on top of the keys, then turn the whole assembly over and solder the keys in position. Make sure that every key is seated right down on the pcb and re-solder if necessary.

Check the pcb for solder splashes, dry joints etc, then double-check the position of every component and check that the polarised components (C11 and all semiconductors) are correctly orientated. Fit and solder the two LED's either externally with two lengths of wire or directly to the pcb. If using our case then the height of the two LED's will have to be carefully adjusted. See Figure 3 for details of lead connections to the LED's. Finally fit and solder the two sockets to the edge of the pcb.

Fit the white plastic caps to the keyswitches noting that two-position caps must be fitted in the 'rubout', 'print', 'newline', 'function' and 'shift lock' positions, and the three-position cap must be fitted over the two keys in the 'space' position. See Figure 4. Carefully cut the printed legend and fit the pieces into the clear caps referring to Table 1. Then turn the transparent covers over and snap them into position on the keys.

Connecting To ZX81

Careful inspection of the two flexible cables will show that at each end a small strip of the insulating cover has been removed one side of the cable. Plug the two cables into the sockets on the keyboard pcb so that this uninsulated strip faces the pcb. Carefully remove the feet on the ZX81 and unscrew the screws beneath them. Remove the base from the ZX81.

Push the two new flexible cables through the slot in the ZX81 case immediately above the '9' and 'Ø' keys on the touch-keyboard. Then remove the five-way cable (from the touch-keyboard to the socket on the ZX81's pcb) from the socket. With reference to Figure 6 plug the new 7-way cable in so that the black stripe on the cable corresponds with pin 1 of SK1 on the Keyboard pcb and KBD4 on the ZX81 pcb. Repeat this operation for the 8-way cable. The black stripe on the new 10-way cable corresponds with pin 1 of SK2 on the Keyboard pcb and A11 on the ZX81 pcb. Note that the new cables are 7-way and 10-way to ensure correct mechanical fit, though in each case the outer two wires are not used electrically.

Strip and tin (apply a thin layer of solder to) the ends of the piece of screened cable. Connect one end to the 3.5mm jack plug as shown in Figure 5 and connect the screen at the other end through the hole (from above) on the pcb marked '0V' and solder under the pcb. Connect a multimeter switched to 10mA DC range or thereabouts with the positive lead connected to the unterminated centre lead of the cable and the negative lead to the track on the pcb

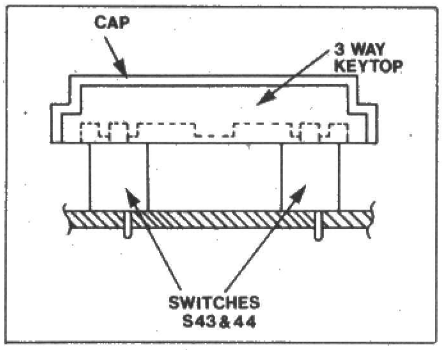


Figure 4. Fitting of 3-way key cap.

immediately beneath the hole marked '+V'.

Plug the adaptor into the ZX81 and plug the mains adaptor into one of the two sockets. Plug the keyboard into the other socket and switch on. LED1 should flash on and then off and the meter should then read less than 1mA. If the meter reads negative or greater than 1mA switch off immediately and re-check all your connections.

If all is well, switch off, remove the multimeter and connect the centre conductor to the pcb by passing the bare end through the hole in the pcb marked '+V' from above and soldering it underneath. Switch on again and test that the keyboard functions correctly.

If the wrong characters are printed you have probably got the flexible cables plugged in the wrong way. Don't worry, this can't do any damage. Unplug the 7-way cable in the ZX81, turn it over and plug it in again. If it still does not work do the same for the 10-way cable. If this does not work, reverse the 7-way cable again.

When all is well, switch off and re-assemble the ZX81, folding the old flexible cables back under the touch-keyboard so that they cannot short anything out on the ZX81 pcb. The new keyboard can now be mounted in its

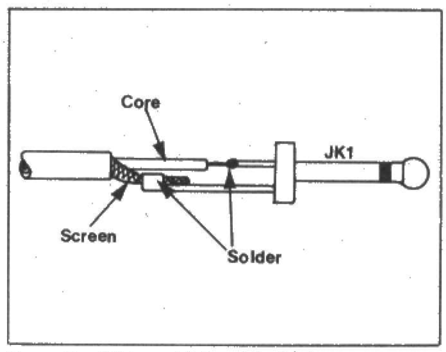


Figure 5. Wiring of 3.5mm jack plug.

box if required. Switch on again. LED1 will flash on and then off and the [K] cursor should appear on the TV screen as usual and you're ready to go.

Circuit Description

S11, the 'graphics 2' key is connected to a buffer/inverter IC1f which together with IC1d acts as a monostable. Operating S11 causes the output of IC1f to go low which in turn causes the output of IC1d to go high, holding the input of IC1f high for the period set by C1, R2.

The output of flip-flop IC2b now goes high and turns on the bilateral switch IC3a which operates the 'shift' function in the keyboard matrix. Also TR1 conducts, turning on LED1. C2 discharges through R3 which delays the output from IC1a from changing state. When it does change over IC1a operates IC3d which connects 'graphics 2' in the keyboard matrix. Further operation of S11 repeats this sequence except that this time IC2b switches low and IC3a and IC3d are released.

S22, the 'function' key is connected to IC1b. When operated, IC3b operates via D4 with C4 and R5 acting as anti-bounce components. D6 becomes reverse biased and C5 discharges via R6,

Continued on page 55

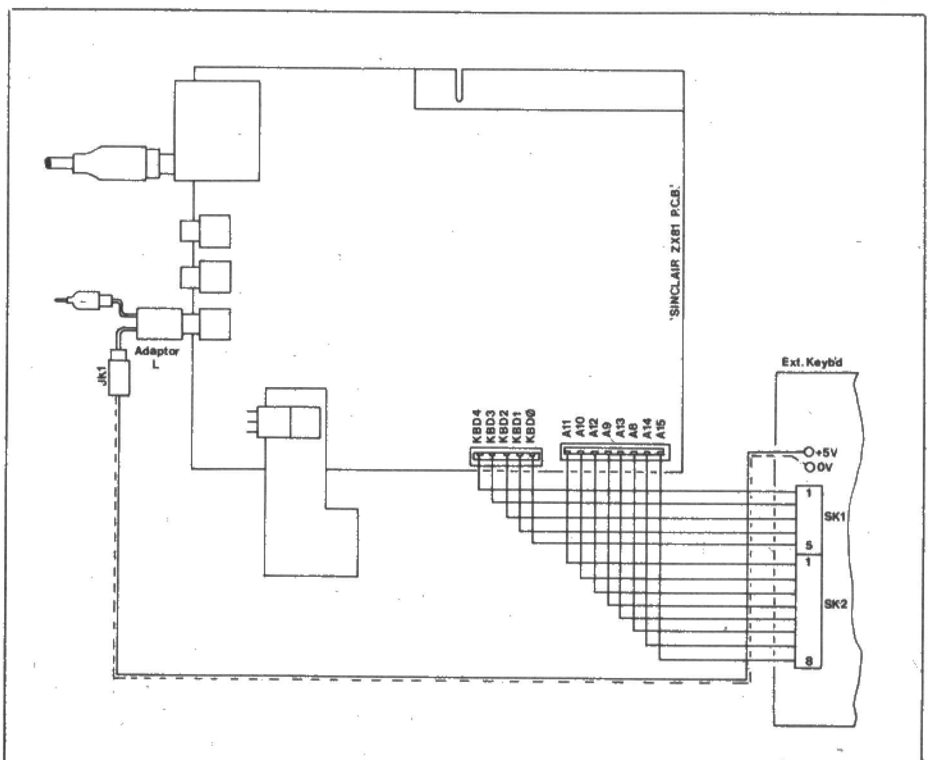
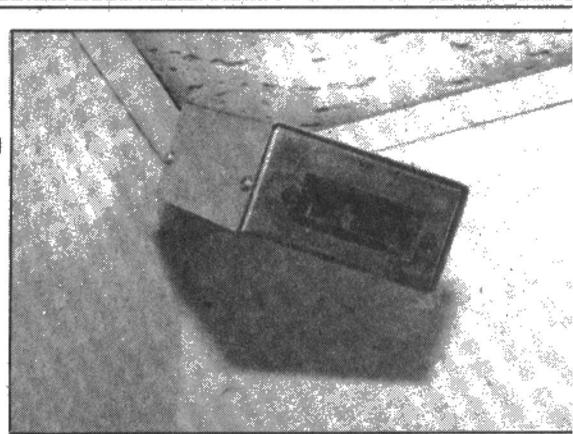


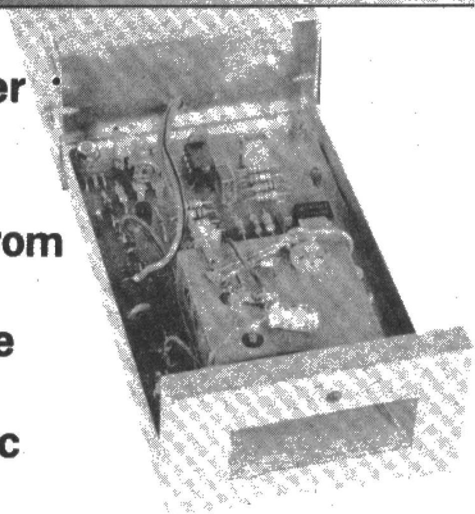
Figure 6. Interwiring.

RADAR DOPPLER INTRUDER DETECTOR

THE MAPLIN RTX3



by Dave Goodman



- ★ **Home Office type-approved microwave Doppler detection system with up to 20m range**
- ★ **Single unit covers a wide area**
- ★ **Not susceptible to instability or interference from sound or light**
- ★ **Complete unit in 133 x 70 x 38mm box can be placed anywhere in area to be scanned**
- ★ **Unit may be hidden behind thin card or plastic**

The Maplin RTX3 movement detector utilises a specially manufactured microwave transceiver module, the CL8960. The module is assembled and preset to transmit at the required legal frequency of 10.687GHz ±12MHz (10,687,000,000Hz) with a peak transmission power of 10mW.

The extremely small wavelength (2.8cm) makes a very sensitive movement detector with coverage of quite a large area. In this design the range is adjustable from about 2m to 20m and the edge of the range is fairly well-defined wherever it is set.

The unit when triggered operates an internal LED and switches on a transistor which could switch up to 15V at 1A, but does not latch. Normally the unit will be used with our controller unit to which up to four of the radar modules could be connected. This control unit can then be used to connect to our Home Security System via the standard Break Contact Module. The control interface is described later in this issue.

Circuit Description

The heart of the system is the CL8960 radar module which consists of two tuned cavities or waveguides and a separate antenna which when fixed to the module gives a gain of around 5dB. One waveguide contains a Gunn diode which produces X-band microwave energy. This diode requires an extremely precise and stable power supply which should be 7V ±100mV at 160mA. This is derived from the 12V power supply by IC1, a precision voltage reference IC and two 1% resistors R3 and R4 that monitor the 7V rail. The current is supplied by TR3, an emitter follower driven by TR1. C1 decouples any hf component in the power supply.

The other waveguide contains a mixer diode which acts as a receiver. There is a small hole between the two waveguides so that some of the transmitted signal passes directly to the

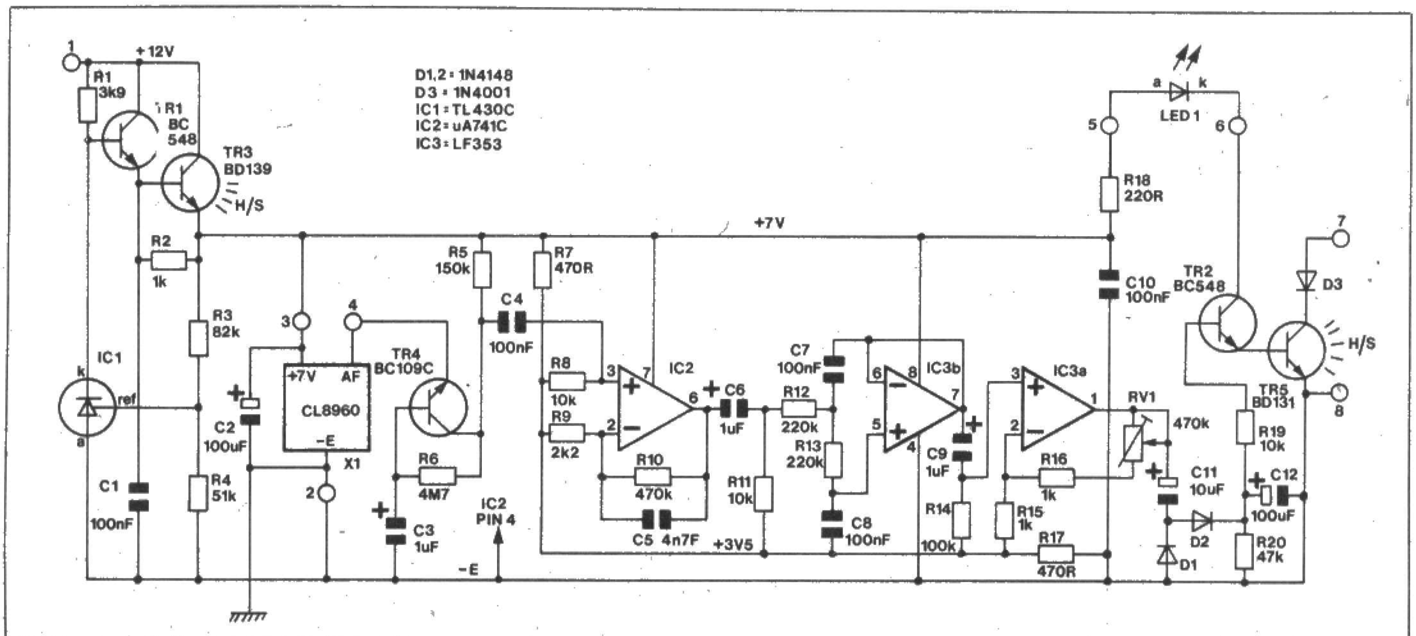


Figure 1. Circuit diagram of Doppler unit.

receiver. The reflected signals from the environment are at exactly the same frequency as the transmitted signal as one would expect. However, if an object moves within the sensitive area, the reflected frequency changes slightly due to the Doppler effect (see box). Even a small movement at this extremely high frequency can make changes of up to 50Hz (although of course this is only a minute change in percentage terms — less than 1 part in a hundred million). For example a movement of 1 metre per second will change the frequency by about 70Hz.

This slightly changed frequency will interfere with the transmitted frequency in the receiver cavity and produce a beat frequency equal to the change. This low frequency beat is output from the mixer diode at the terminal marked 'AF'. The mixer diode requires biasing at about 38uA with a low impedance (600Ω), therefore TR4 is required to be a common base amplifier with the bias current supplied by R5.

The AF signal is then AC coupled to IC2, a non-inverting amp and C5 ensures that only low frequencies are amplified. IC3b is a low-pass filter with a cut-off frequency around 40Hz. If higher frequencies are allowed to pass, the unit is prone to false triggering from for example mains-operated lighting, especially fluorescent lamps. The combined filtering in IC2 and IC3b eliminates this possibility.

IC3a is a variable gain amplifier which is preset by RV1 to allow you to adjust the overall receiver sensitivity so that areas from 2m to 20m can be covered reasonably accurately. C11 and 12 and D1 and 2 remove the AC component from the audio signal and provide a DC bias to switch TR2 and LED1. If no further movement is detected, LED1 turns off after about 3 to 4 seconds as set by R20.

Pins 7 and 8 will normally be left unconnected, but if the unit is not being used with our control interface then these two pins can be wired to an external switching system and an external power supply not exceeding 15V at 1A must be used. See Figure 5.

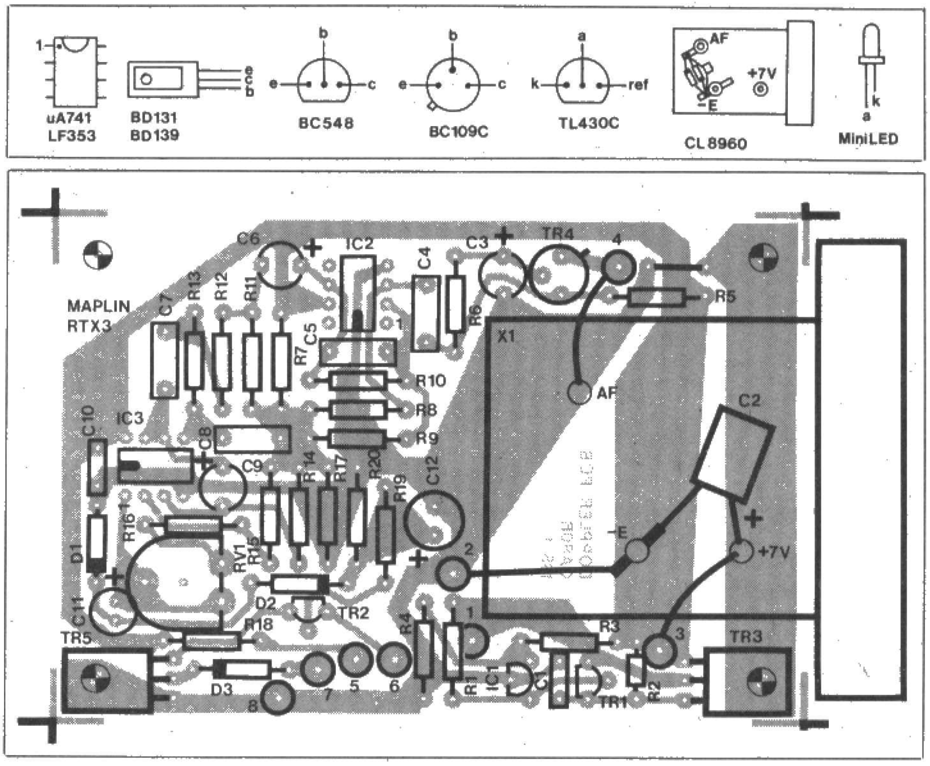


Figure 2. Component overlay of Doppler unit.

THE DOPPLER EFFECT

In 1842 an Austrian physicist, Christian Doppler discovered that the velocity of a sound source can change the frequency of that sound as perceived by an outside observer. For example if a car sounding its horn rapidly approaches an observer, the observer will note that as the car passes him the frequency of the horn drops. Although this is sound radiation, the same effect occurs with electro-magnetic radiation.

The reason for this is that for sound or electro-magnetic radiation, the speed of propagation (in the same medium) does not change. For electro-magnetic radiation this speed is about 300 million metres per second and generally denoted as 'c'. This speed remains the same regardless of the velocity of the source of the radiation relative to the observer.

Thus if a stationary source radiates for one second, the wave train produced will be 300 million metres long. Now imagine that the source moves away from the observer during the second when the radiation is emitted. The leading edge of the wave train will be 300 million metres from where the source was when the radiation started, but the end of the wave train will be where the source is at the end of the second.

So the length of the wave train is now 300 million metres plus the distance travelled by the source in that second. Since the transmitted frequency did not change, there must still be the same number of waves in this longer wave train as in the first one. If the observer now "listens" to this radiation for precisely one second, he will of course receive 300 million metres worth of both wave trains. The first wave train will contain all the waves transmitted, but the second wave train will not contain all the waves transmitted (because as we've seen there is actually more than 300 million metres worth of them). If there are fewer waves in the same distance then the distance between each wave must be greater. In other words the wavelength is longer and if the wavelength is longer then the frequency is lower.

In fact the observer would never know (unless he had other information) that it was not a stationary source that transmitted both signals. In the second case he would think that the source actually transmitted a lower frequency signal for a slightly longer time.

If the source had moved towards the observer during the transmission period, then the wave train would be shorter, the wavelength shorter and the frequency higher.

Construction

Insert the links and the 8 pins on the pcb, then taking care with the orientation of the diodes, IC's, transistors and C2, 3, 6, 9, 11 and 12 place the rest of the components except TR3 and TR5 and solder them all in position. Carefully align TR3 and TR5 above the holes in the pcb and then solder them in position, noting that no insulating washer is required. Drill the box and make the cut-out as shown in Figure 3, then place a 6BA ½in bolt in each of the four corner holes in the base and tighten a nut and washer on each bolt. Then sit the pcb on the nuts and fix with another nut and washer as shown in Figure 4.

Fix the antenna to the front plate of the box using two 6BA bolts. Now fix the CL8960 to this and tighten up. The CL8960 is supplied with two back-to-back diodes and a capacitor connected across the mixer diode for protection. These components must NOT be removed. Mount C2 from the +7V pin to the 0V pin as shown in Figure 2. Fix the LED either directly to pins 5 and 6 or to the hole marked 'A' in Figure 3. Connect the two wires between the pcb and the CL8960 as shown in Figure 2.

The 12V supply wires can now be connected; the positive to pin 1 and the negative to the CL8960 as shown in Figure 4. Make absolutely certain that you have connected the supply the right way round. Temporarily disconnect the wire from pin 3 on the pcb and connect a voltmeter between that pin and the chassis (0V). Connect the power supply. The voltmeter should read within ±1% of 7V, but many lower cost multimeters have far less accuracy than TL430C and in fact if your multimeter reads within ½V of 7V then it is very unlikely that there is a fault in the circuit. If all is well, remove the power supply, reconnect the wire to pin 3 and switch on again. The unit is now functioning.

The completed module is ideally situated in the corner of a room, but could be placed almost anywhere and may be disguised by covering the front. Any such covering should be thin paper, card or polystyrene and must be positioned not less than 2.5cm (1in) from the front of the box.

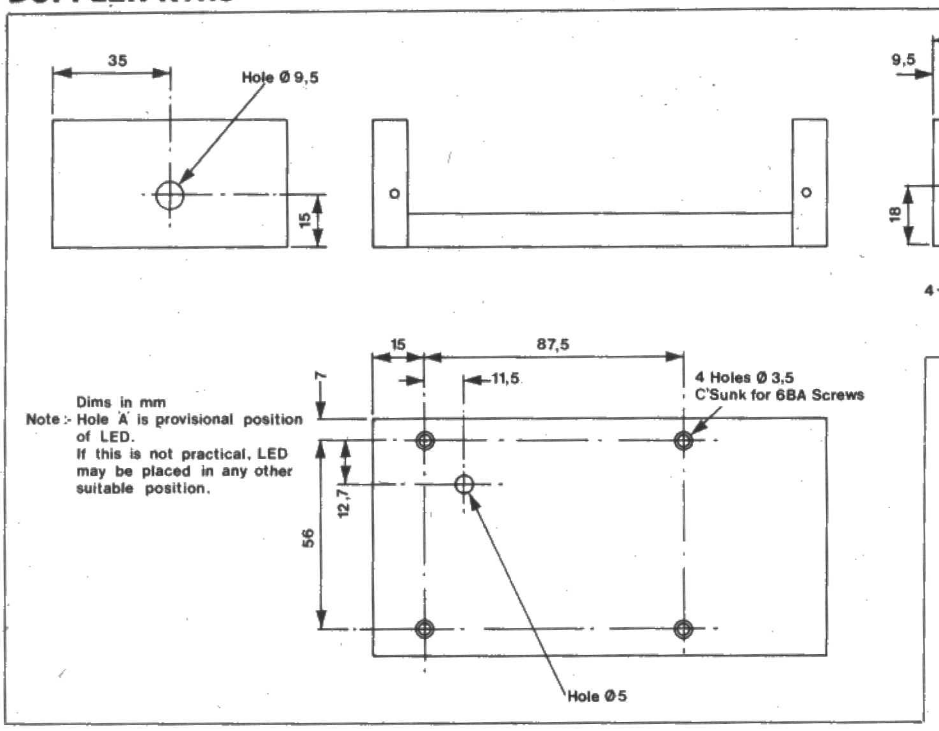


Figure 3. Box cut-out and drilling.

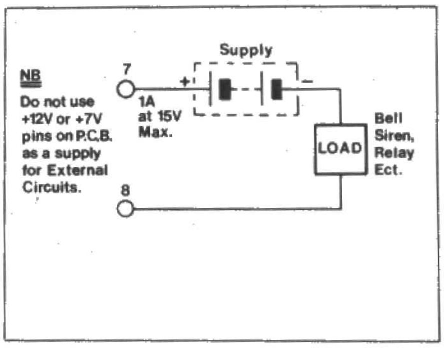


Figure 5. Wiring of external alarm if not used with control unit.

Licensing Requirements

The Maplin RTX3 radar intruder detector has been approved by the Home Office if built from our kit of parts. The licence will only be issued if the following requirements are met:

i. The unit must be built from our kit and our construction details must be followed implicitly.
ii. The equipment must be clearly and permanently marked "MAPLIN RTX3" and the kit includes the adhesive label required.
iii. The equipment must only be used indoors.
iv. The equipment must not be used for any purpose other than intruder detection within buildings.
v. Any technical changes made to the design will render the equipment unacceptable for licensing.

Provided that the above conditions are met, the Home Office will issue a licence and the cost is only £3 for five years (at time of writing). You should note that it is illegal to operate the unit before you have a licence and to this end an application form is supplied with the kit. Otherwise application forms are available from:

Home Office,
Radio Regulatory Dept.,
R2 Division — Licensing Branch,
Waterloo Bridge House,
London SE1 8UA.
(Telephone 01-275 3058).

The application form must state that the equipment to be licensed is the MAPLIN RTX3 intruder detector otherwise a licence will not be issued.

We should like to thank those concerned at the Home Office for their assistance and for the prompt way in which our application for type-approval was dealt with. Continued on page 62

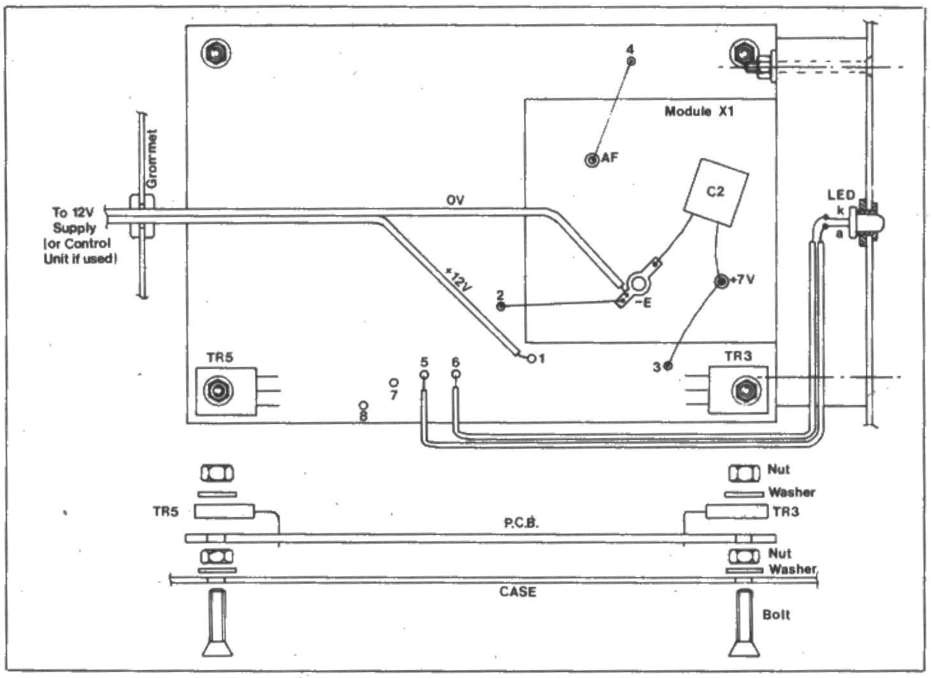
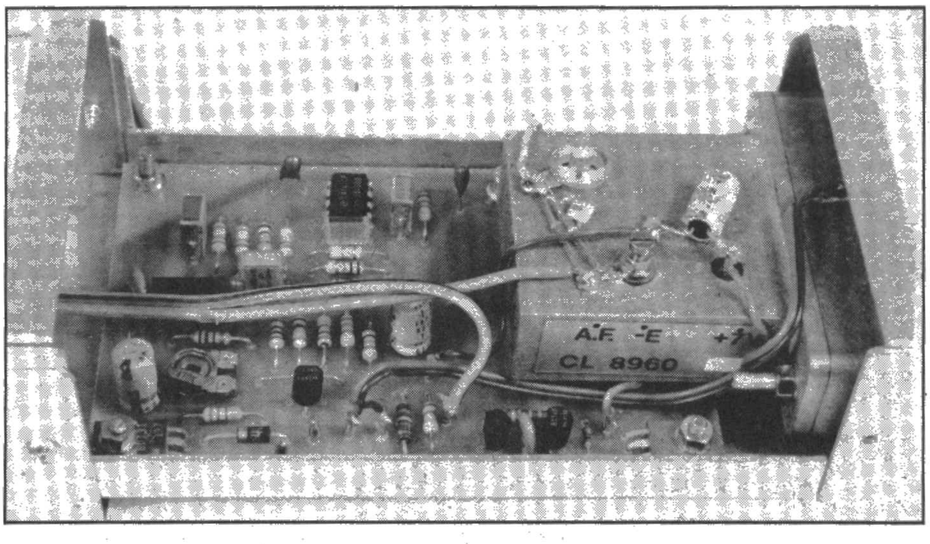


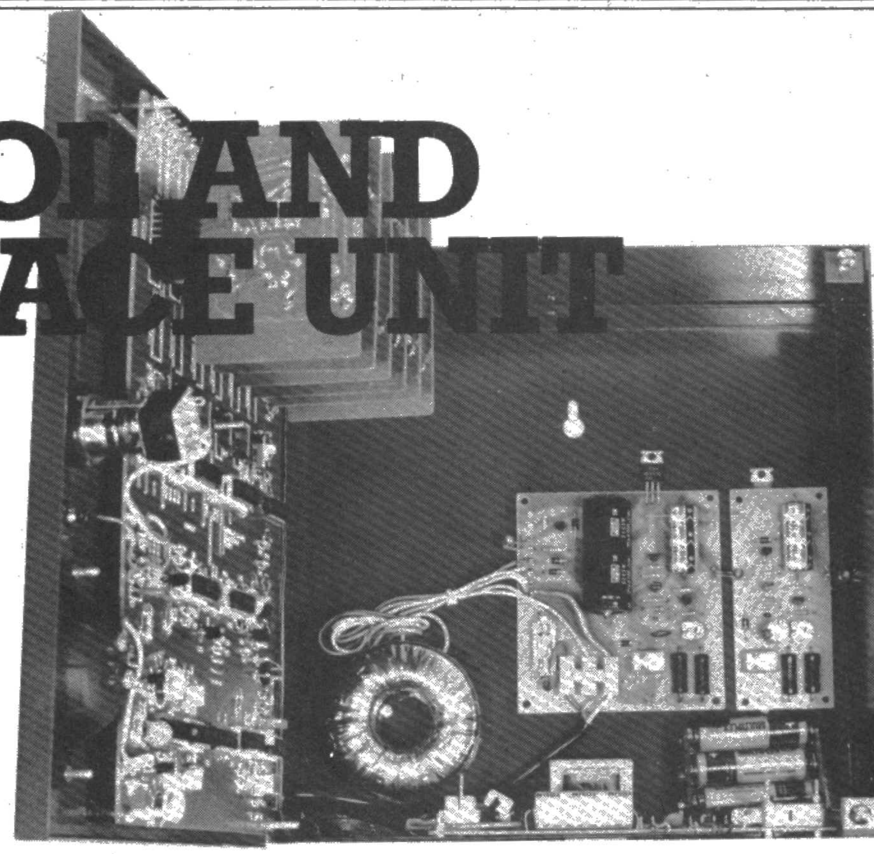
Figure 4. Assembly.



DOPPLER MODULE

CONTROL AND INTERFACE UNIT

by Dave Goodman



This unit provides a power supply for up to four radar modules and an interface for one radar module. Additional "extra channel" pcb's can simply be wired on to the side of the main pcb. Thus each interface module could be wired to individual channels on the Home Security System (described in issue 2) so that after triggering, the actual unit that fired would be indicated. Alternatively if that facility is not required then simply connect the relays in series as shown in Figure 1a and connect them to just one channel on the Home Security System.

The module provides the facility to connect a standby battery pack. Twelve nickel cadmium batteries are required and they are trickle-charged all the time mains is present. When mains fails, the batteries take-over without triggering the alarm. The size of battery used will depend on how many radar units are being used and how long you wish standby to last after mains fails.

The current drain from the battery for each radar module is 170mA. Thus with 12 fully charged 'C' cells (1800mAh types), four modules would run for about three hours and a single module for about 12 hours. Alternatively, a single module would run from 12 'AA' cells (500mAh) for about 3 hours.

If standby batteries are not used then although when mains fails the radar units cease to function and the alarm is not triggered, when mains returns, the radar units, in taking a few seconds to settle, will trigger the alarm. So it is a considerable advantage to have standby batteries and avoid this kind of false triggering.

This unit could be used with any alarm system, but note that the relay contact does not latch. The maximum contact rating is 1A at 24V DC.

Circuit Description

The unit runs directly from 240V AC mains via a 15V 30VA toroidal transformer. The secondary voltage is half-wave rectified and smoothed by C1 producing about 24V off-load. TR1 forms a constant current charger for the standby battery with the current set to 6mA by R2. Diode D3 is reverse

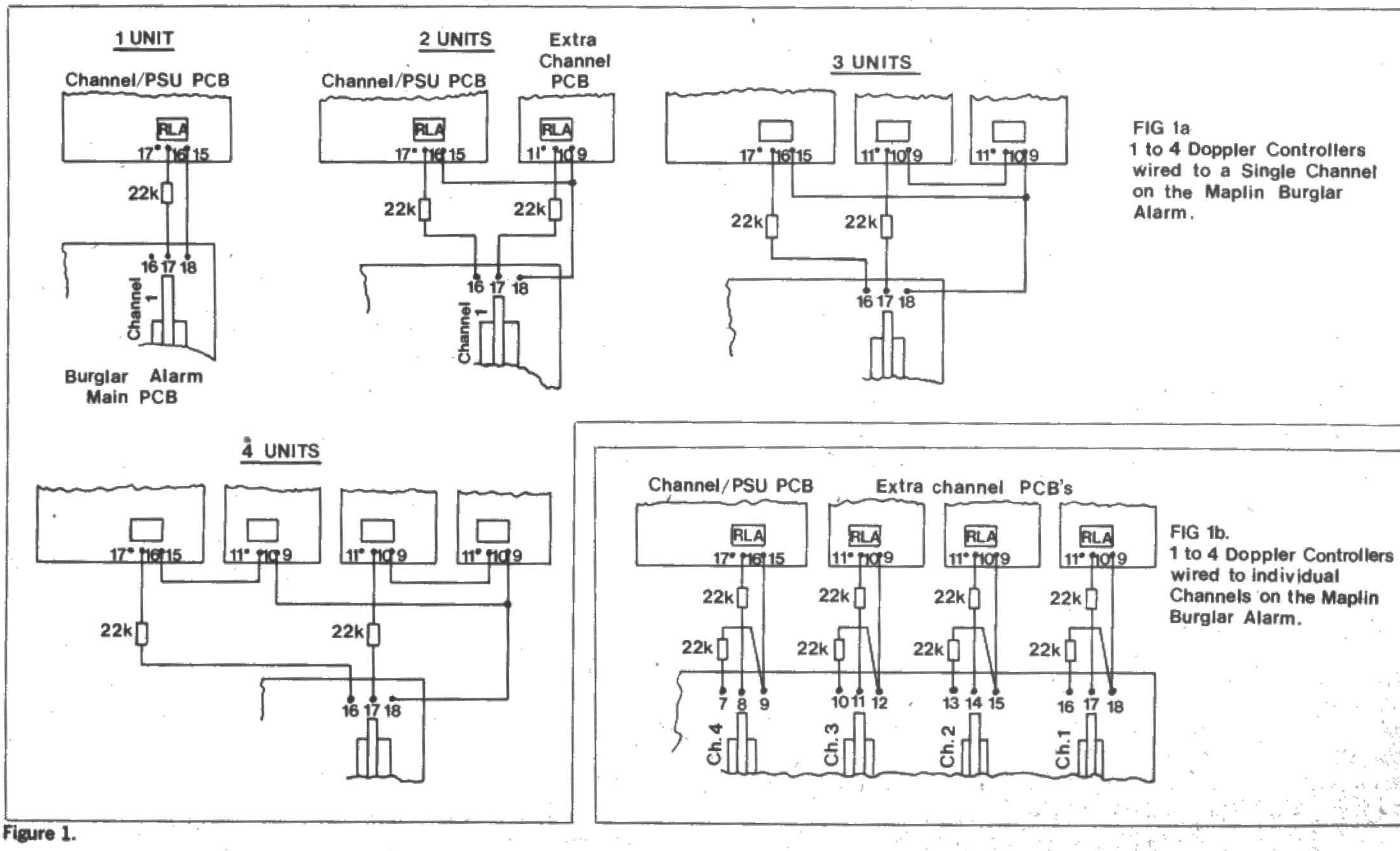


FIG 1a
1 to 4 Doppler Controllers wired to a Single Channel on the Maplin Burglar Alarm.

FIG 1b.
1 to 4 Doppler Controllers wired to individual Channels on the Maplin Burglar Alarm.

Figure 1.

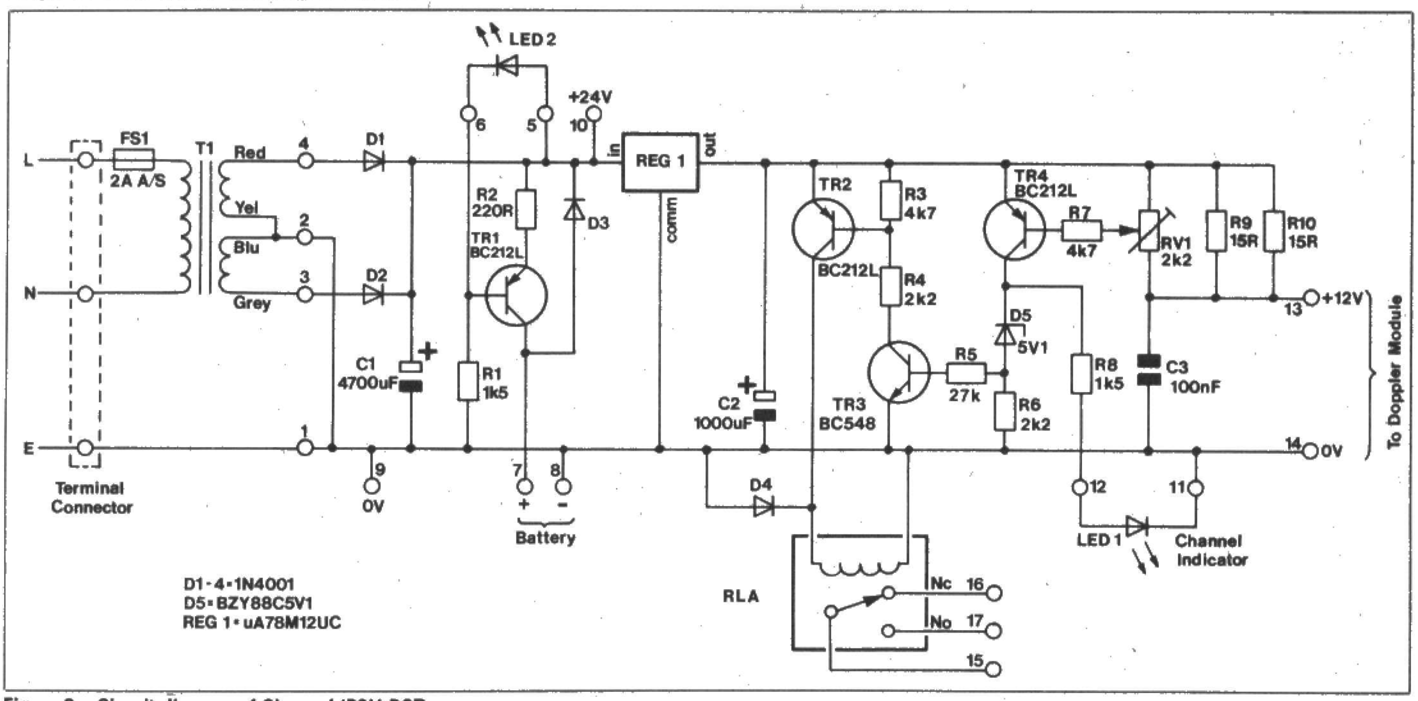


Figure 2. Circuit diagram of Channel/PSU PCB.

biased when mains and batteries are present, but when mains fails it becomes forward biased and the +24V rail drops to +15V. This is just sufficient to maintain the output of Reg 1 at 12V.

With a Doppler module connected to pins 13 and 14, the current through R9 and R10 in parallel provides a biasing voltage across RV1. With RV1 correctly adjusted, TR4 will be just turned on enough to light LED1, but not enough to operate TR3. TR2 will therefore not conduct and the relay will remain unoperated. If the Doppler module is triggered, the LED in the Doppler module lights and causes a tiny current change through R9 and R10. This change turns TR4 fully on and TR3 will turn on. This operates TR2 and the relay switches. The relay will only remain operated whilst the LED in the Doppler module is on.

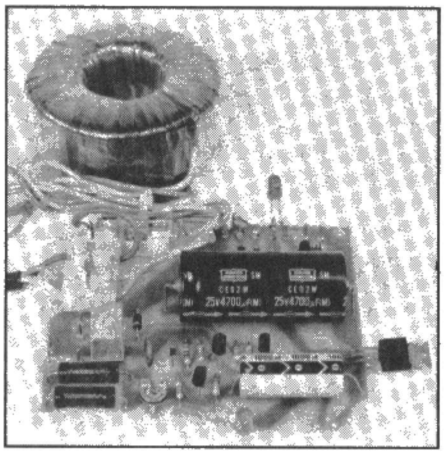
The advantage of this system is that only two wires are required and the wires themselves are constantly monitored. The alarm will fire if the wires are cut or short-circuited.

The extra channel pcb's as shown in Figure 3 are identical except that the power supply prior to the regulator is not included.

Construction of Channel/PSU PCB

Fit all the resistors, R1 to R10 and fit RV1 and solder. Fit and solder diodes D1 to D4 and Zener diode D5 taking care with orientation. Fit and solder the 17 Veropins and the disc capacitor C3, then C1, C2 and TR1 to 4 taking care with the orientation.

Relay RLA will only fit one way round, but be careful not to force the terminals, they should be carefully straightened and should then fit easily. Reg 1 can now be fitted below the pcb, then soldered and bent up so that it lies parallel with the pcb as shown in Figure 5.



Bolt the 3-way connector block to the pcb using two 6BA ½in bolts and nuts, then bolt the fuseholder to the pcb using a 6BA ¼in bolt and nut. LED1 and LED2 can now be connected as shown in Figure 4. These can be mounted directly to the pcb or externally depending on your requirements. LED2 shows that power is on and must be included if standby batteries are used. LED1 is used during testing, but can be omitted in use. If fitted, it lights when a Doppler module is connected.

Wire up the six colour-coded leads from the transformer as shown in Figure 4. Cut 8cm (3in) off the piece of mains cable (note that this is not

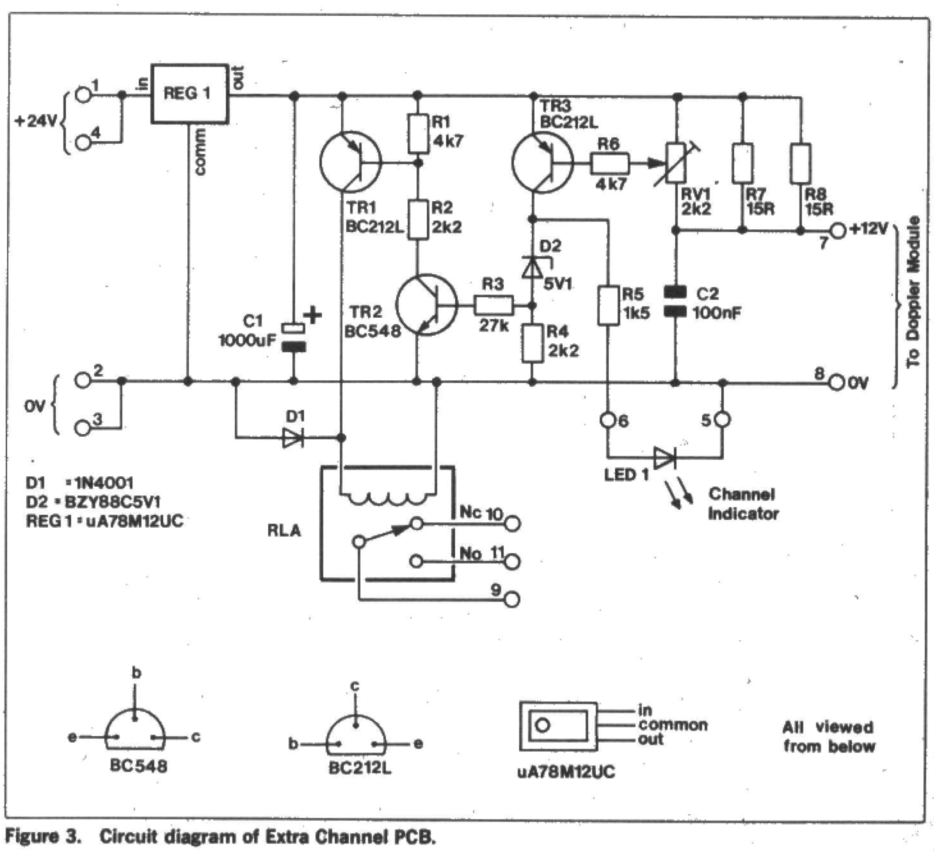
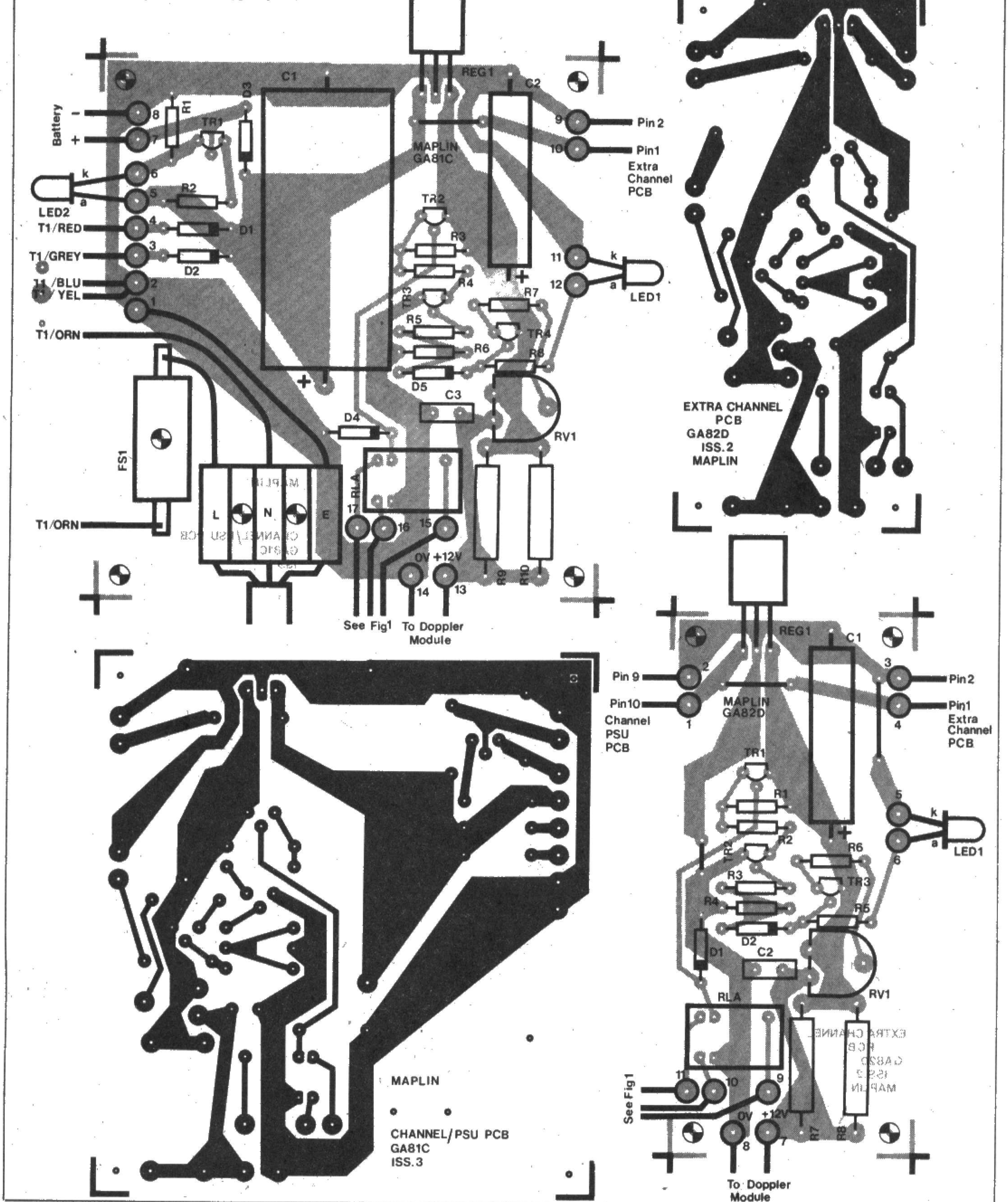
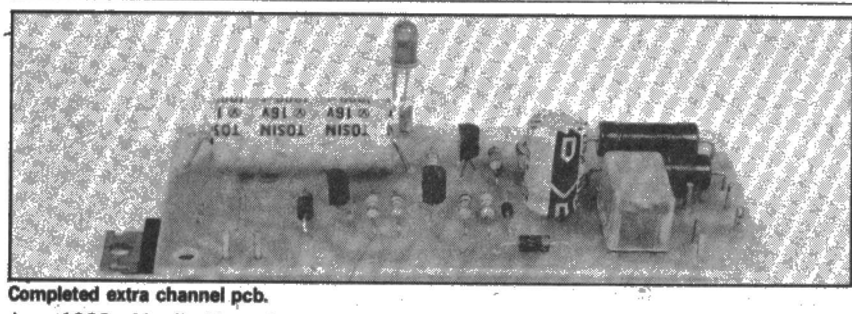


Figure 3. Circuit diagram of Extra Channel PCB.

Figure 4. Track layout and overlay of pcb's.





Completed extra channel pcb.

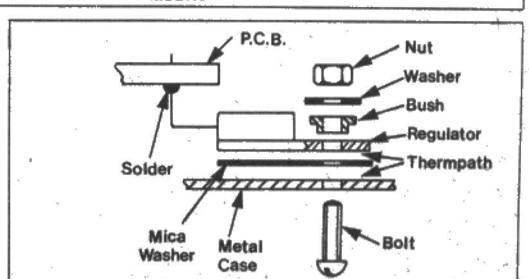


Figure 5. Mounting regulator 1.

supplied in the kit) and use the piece of brown wire to connect from the terminal block live to FS1. Use the piece of green/yellow to connect from the terminal block earth to pin 1. These connections are shown in Figure 4. The mains cable itself can now be connected to the other side of the terminal block and this is also shown in Figure 4.

Construction of Extra Channel PCB's

Extra channel pcb's can now be constructed in the same way as the channel/psu pcb's, though of course there are less components. The LED on this board is exactly the same as LED1 on the channel/psu pcb and again although required during testing, it can thereafter be omitted if not required.

Assembly

Mount the transformer with the mounting kit supplied with the transformer and then fix the pcb's side-by-side (if extra channel pcb's are in use) so that pin 9 on the channel/psu pcb is adjacent to pin 2 on the extra channel pcb and, if further extra channel pcb's are in use, so that pin 3 on the left-hand one is adjacent to pin 2 on the right-hand one.

Fix the boards using four ½in spacers and four 6BA ½in nuts, bolts and washers. With reference to Figure 5, bolt the regulator to the metal box using the mounting kit smeared with silicone grease e.g. Thermpath (not supplied in kit) and a 6BA ¼in bolt, nut and washer. The size of metal box in which the unit is mounted will depend on how many channels you require and whether you are having standby batteries, but whatever the size this will be a sufficient heatsink for the regulator.

When choosing a box, remember to leave room for the standby batteries. These can be fitted using our battery holders e.g. for 'C' cells use three HF95D or HF96E and for 'AA' cells use two HQ01B or YR62S. There may be sufficient room for everything in the main box of the Home Security System in which case the back of the box will form the heatsink for Reg 1.

If more than one channel is in use, then wire the pcb's together with strapping wire by linking the pins as follows:

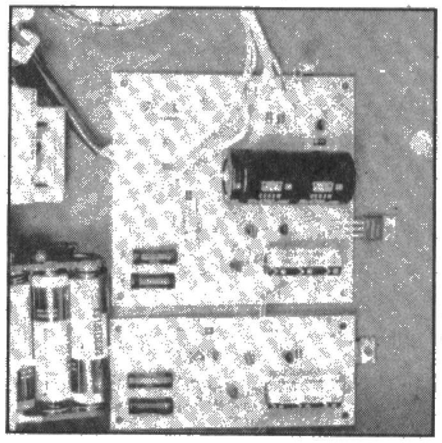
Channel/PSU PCB		Extra Channel PCB
pin 9	to	pin 2
pin 10	to	pin 1

The extra channel pcb can then be extended on again as follows:

1st or 2nd Extra Channel PCB		2nd or 3rd Extra Channel PCB
pin 3	to	pin 2
pin 4	to	pin 1

Setting-up

Switch the mains on and measure the voltage between pin 13 and 14 on the channel/psu pcb and between pin 7 and pin 8 on the extra channel pcb. The meter should read approximately 12V. Note that pins 14 (and 8) are 0V and the +12V should be on pins 13 (and 7). The pin numbers in brackets are for the extra channel pcb.



If all is well, connect a Doppler module to pins 13(7): +12V and 14(8): 0V. Adjust RV1 so that LED1 lights and check that if the Doppler module is removed the LED extinguishes. Reconnect the Doppler module and continue adjusting RV1 until the relay operates i.e. the LED and relay are now both operated.

Now turn the preset back until it is roughly in the middle of the region between the LED operating and the relay operating, i.e. the LED is now operated and the relay released. Connect a 2k to 3k resistor across pins 13(7) and 14(8) with the Doppler module still connected and check that the relay operates. Otherwise further adjustment of RV1 will be necessary. Remove the resistor. The output can now be wired as shown in Figure 1. ■

CHANNEL/PSU PARTS LIST

Resistors — all ¼W 5% carbon unless specified			
R1,8	1k5	2 off	(M1K5)
R2	220R		(M220R)
R3,7	4k7	2 off	(M4K7)
R4,6	2k2	2 off	(M2K2)
R5	27k		(M27K)
R9,10	15R (7W wirewound)	2 off	(L15R)
RV1	2k2 horizontal sub-min preset		(WR56L)
Capacitors			
C1	4700uF 25V axial electrolytic		(FB96E)
C2	1000uF 16V axial electrolytic		(FB82D)
C3	100nF disc ceramic		(BX03D)
Semiconductors			
D1,2,3,4	1N4001	4 off	(QL73Q)
D5	BZY88C5V1		(QH07H)
LED1,2	LED red	2 off	(WL27E)
TR1,2,4	BC212L	3 off	(QB60Q)
TR3	BC548		(QB73Q)
REG 1	uA78M12UC		(QL29G)
Miscellaneous			
T1	Toroidal 15V 30VA		(YK11M)
RLA	Ultra min relay SPDT		(YX94C)
FS1	20mm A/S fuse 2A		(WR20W)
	Chassis fuseholder 20mm		(RX49D)
	Mounting kit (P) plas		(WR23A)
	Channel/PSU pcb		(GA81C)
	Terminal block (3-way)	part of	(HF01B)
	Veropin 2141	17 off	(FL21X)
	Bolt 6BA ¼in	2 off	(BF05F)
	Bolt 6BA ½in	6 off	(BF06G)
	Spacer 6BA ¼in	4 off	(FW34M)
	Washer 6BA	5 off	(BF22Y)
	Nut 6BA	8 off	(BF18U)
	Strapping wire 24swg	1m	(BL15R)
	*Mains cable	as required	(XR01B)
	*Thermpath	as required	(HQ00A)

A complete kit of parts containing all the above items except those marked * is available.
Order As LW74R (Radar Channel/PSU Module) Price £13.95

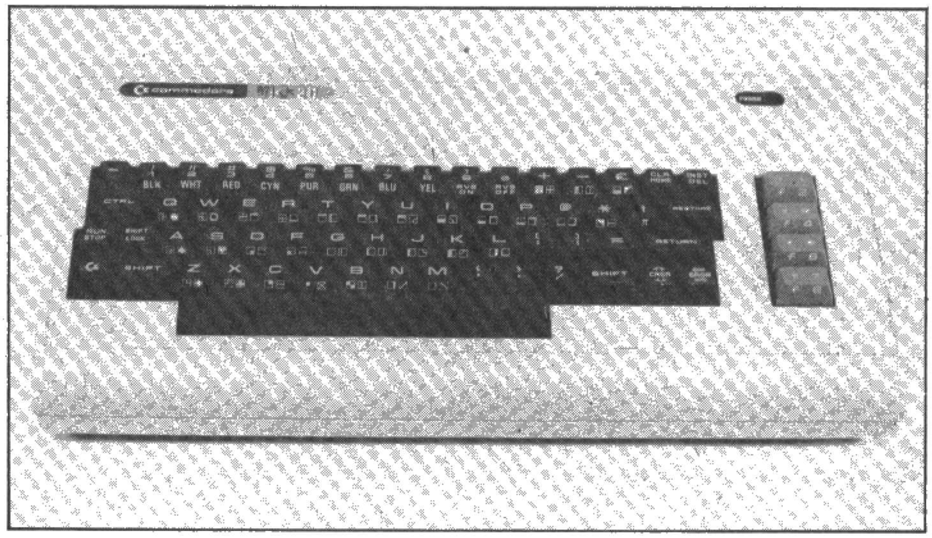
EXTRA CHANNEL PARTS LIST

Resistors — all ¼W 5% carbon unless specified			
R1,6	4k7	2 off	(M4K7)
R2,4	2k2	2 off	(M2K2)
R3	27k		(M27K)
R5	1k5		(M1K5)
R7,8	15R (7W wirewound)	2 off	(L15R)
RV1	2k2 horizontal sub-min preset		(WR56L)
Capacitors			
C1	1000uF 16V axial electrolytic		(FB82D)
C2	100nF disc ceramic		(BX03D)
Semiconductors			
D1	1N4001		(QL73Q)
D2	BZY88C5V1		(QH07H)
LED1	LED red		(WL27E)
TR1,3	BC212L	2 off	(QB60Q)
TR2	BC548		(QB73Q)
REG 1	uA78M12UC		(QL29G)
Miscellaneous			
RLA	Ultra min relay SPDT		(YX94C)
	Mounting kit (P) plas		(WR23A)
	Extra channel pcb		(GA82D)
	Veropin 2141	9 off	(FL21X)
	Bolt 6BA ¼in		(BF05F)
	Bolt 6BA ½in	4 off	(BF06G)
	Spacer 6BA ¼in	4 off	(FW34M)
	Washer 6BA	5 off	(BF22Y)
	Nut 6BA	5 off	(BF18U)
	*Thermpath	as required	(HQ00A)

A complete kit of parts containing all the above parts except that marked * is available.
Order As LW75S (Radar Extra Channel Module) Price £4.50

THE VIC 20 COLOUR COMPUTER

by Chris Barlow



Commodore, the manufacturers of the VIC20 are already a well known name in the micro-computer world. Their PET micro-computer has sold more than 50,000 units in the UK, mostly to schools and businesses. Its popularity in schools is probably due to Commodore's excellent programming language PET BASIC which is one of the easiest computer languages to learn. This same BASIC is supplied with the VIC20. In fact all the best features of the PET have been included in the VIC, but because a monitor is not included, the price is much lower.

The VIC20 is a full-fledged computer and is truly expandable into a very sophisticated computer system. Although it doesn't have its own monitor like the PET, it can be used with any ordinary domestic television (625-line PAL) and simply plugs straight into the aerial socket like a video recorder or home games machine. With every computer there is a friendly guide called "Personal Computing On The VIC20" that explains to every owner, including the first-time user, exactly how to get good results from the VIC20.

The best way to get to know the VIC20 is to take a quick tour of the keyboard. The keyboard contains upper and lower case keys, numbers and symbols, just like a typewriter keyboard. In addition, there are special editing keys, and the famous "PET GRAPHICS" character set. Here then, is a brief "tour" of the VIC keyboard:

Graphics & the Commodore Key

When you turn on the VIC, you're automatically in "graphics" mode which means you can type upper case letters AND the more than 60 graphics you see on the keys. There are two graphics on each key. To get the graphic on the right side, simply hold down the SHIFT key and type the key with the graphic you want. To get the graphics on the left side, hold down the "COMMODORE" key (the little flag). In this way, you can type upper case letters and the full graphics set at the same time!

Upper/Lower Case & Graphics

To get into the "text" mode you simply press the SHIFT and COMMODORE keys together. This lets you use the VIC like an ordinary typewriter, with full upper and lower case letters, plus all the graphics on the LEFT side of the keys. These are the graphics which are most suited for charts, graphs and business forms.

Colour

You can change the colours of the characters you type by pressing the CTRL key and one of the 8 colour/number keys. The colours are black, white, red, cyan, purple, green, blue and yellow. You can set — and change — colours inside or outside a computer program. In addition to the eight character colours, you can also change the colours of the border and screen on your television set, by typing a special command called a "Poke". For example, if you type the command Poke 36879, X where X is some number from 1 to 255, you can get up to 255 different combinations of screen and border colours, including 16 screen colours and 8 border colours.

Special Editing Keys

Here are some of the other special keys which make the VIC such a powerful micro-computer:

CTRL — used to set character colours, and, in conjunction with special programs such as wordprocessing, to execute special commands.

Software writers can select their own "Control" commands and incorporate them into their programs.

Run/Stop — The run/stop key lets you automatically load programs into the VIC's memory from a cassette tape. Hitting this key without shifting (i.e. Stop) interrupts a running program or listing. If you stop a program and want to resume it where you left off, you can type "cont" and the program will "continue".

Shift — The VIC has two shift keys and a shift lock key, just like a typewriter, for typing long strings of upper case letters or graphics.

RVS on and RVS off — These two keys let you type reverse characters on the screen (for instance white on black instead of black on white).

Joystick Demonstration Program

```
10 PRINT "]" : X = 7680 : Z = Ø : V = 1 : POKE
   37154, 127
20 FOR C = 38400 TO 38960 : POKE C, 6 :
   NEXT C
30 A = PEEK (37151) : POKE X, 224
40 IF A = 122 THEN X = X-22 : V = V-1 :
   IF V  1 THEN X = X+22 : V+1
50 IF A = 118 THEN X = X+22 : V = V+£ :
   IF V  23 THEN X = X-22 : V = V-1
60 IF A = 110 THEN X = X-1 : Z = Z-1 :
   IF Z  Ø THEN X = X+1 : Z = Z+1
70 IF PEEK (37152) = 119 THEN X = X+1 :
   Z = Z+1 :
   IF Z  21 THEN X = X-1 : Z = Z-1
80 GOTO 30
```

CLR/Home — This key makes the cursor move to the "home" position at the top left hand corner of the screen. If you type shift and CLR/home you "clear" the screen of all the characters that were present.

Inst/Del — This is a super editing key which lets you insert or (shifted) delete characters. It's great for correcting mistakes and inserting extra information.

Restore — This is a "reset" key. If you type the run/stop key and the restore key together, you complete reset the computer as if you had just turned it on . . . with the benefit that any programs you had in the memory are retained and can be listed or run from the start.

Cursor Keys — Ability to move the screen cursor up and down and sideways by hitting single keys is a powerful feature of the VIC. Being able to move the cursor this easily is essential but not all computers include it as a feature.

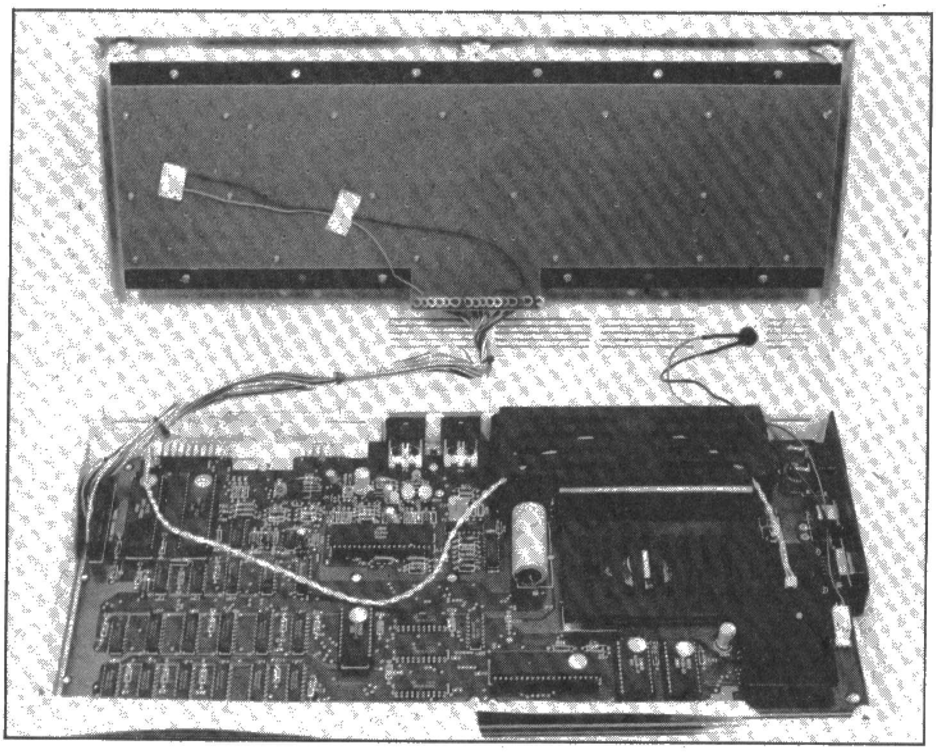
Return — The return key is used primarily for entering commands and instructions to the computer.

Programmable Function Keys

One of the most unique features on the VIC is that mysterious vertical row of "function" keys on the far right side of the keyboard. There are four keys and (if you shift them) a total of eight functions. These keys are not defined when you turn on the computer, but you may assign any BASIC command or instruction set to them, under program control.

Inside the VIC20

Inside the VIC20 there are some very powerful integrated circuits. The microprocessor chip itself is the 6502. The memory is divided into two parts. The first part is the ROM (read only memory) that stores the BASIC, the alpha-numeric characters and the graphics characters, input and output routines and the operating system 'Kernal'. The total amount of ROM supplied is 20K, but this can be increased to 32K, and addresses 40960 to 49151 are reserved for plug-in ROM such as VIC's game cartridges.



Colour Demonstration Program

```
10 PRINT "⊐" POKE 36879, 8
20 FOR D = 7680 TO 8185 : POKE D, 224 :
   NEXT D
30 C = INT (RND(1)x506) + 38400
40 A = INT (RND(1)x8) : IF A  1 THEN 40
50 POKE C, A : GOTO 30
```

The second part of the memory is RAM. The VIC20 contains 5K of static RAM (2114) and 3.58K of this is free space for your programs. More RAM can be added up to a total of 32K and addresses 8192 to 32767 are reserved for further expansion of RAM. The first part of RAM is allocated to BASIC working storage and tape buffer, screen storage etc.

The second important chip in the VIC is the one from which the name of the computer is derived. This chip, a 6561, is a video interface chip (VIC). It is a powerful colour graphics and sound generator and incorporates two 8-bit analogue to digital converters for two paddles for playing arcade-type games. The VIC also generates the video sync., luminance and colour information needed by a standard UK television to provide a full colour picture.

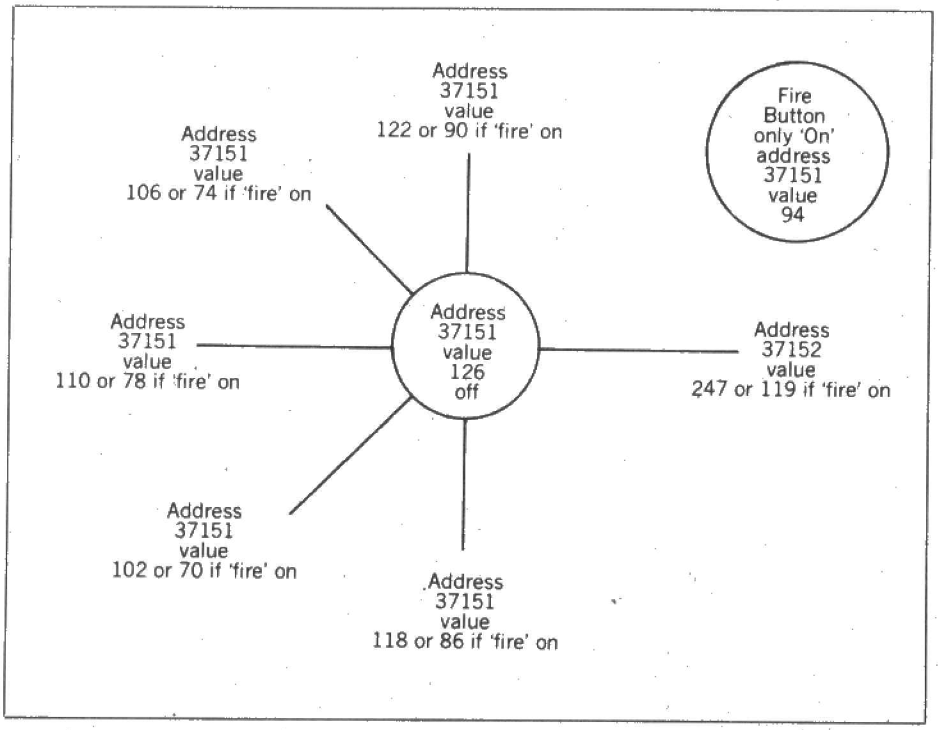
To produce programmable colour characters, VIC accesses three areas of memory — display characters, character pointers and colour pointers. Each character is stored in a cell of 8 x 8 bits and it is this data that makes up each of the characters stored in ROM. However, it is possible under software control to write your own character set in RAM, remembering of course that a complete set will take up 4K in the memory.

Most computer games use re-defined characters to create the special symbols and objects such as those used in Commodore's Alien Invaders or Tank Command or Air Sea Battle, etc. Re-defined characters could also be used though to make musical notes or the characters for foreign languages or scientific symbols etc.

The video screen is stored in RAM locations 7680 for the top left-hand corner of the screen to 8186 for the bottom right-hand corner. The position of this RAM will move if more RAM is added to the VIC20. If there is more than 8K of RAM then the addresses change to 4096 to 4602.

Similarly the colour addresses for the screen display start at address 38400 for the top left-hand corner and go to 38906 for the bottom right-hand corner. The values stored in these addresses set the colour of the character displayed on the screen in each position. Again the addresses move if there is more than 8K of RAM fitted. The new addresses are 37888 to 38394. In the Colour Demonstration program shown in the panel, remember to change the addresses if you have more than 8K of RAM.

The VIC chip has many more functions, but we have quickly covered here some of the more useful ones.



The VIC 20 Joystick.

The VIC20 Joystick

The VIC20 has provision for a joystick and this can be used in games or simulation programs. Inside the joystick are five switches. Four switches are for joystick movement and one is the 'fire' button. When the joystick is in a diagonal position, two of the four movement switches will be closed and this sets a particular value in the VIC20. These joystick position values are stored in addresses 37151 and 37152 as shown in the diagram.

The value in address 37151 changes when the joystick is moved to close the switches for up, down and left and it also changes when the fire button is pressed. If the joystick is central and therefore no switch is closed then the value in 37151 is set to 126. This changes to 94 if the fire button is pressed. if the joystick is moved to close the 'up' switch, the value changes to 122 or to 90 if the fire button is pressed and so on as shown in the diagram.

The fourth stick switch changes the value in location 37152, but this address is also used for keyboard scanning. To make this location 'see' the joystick, you have to POKE 127 at address 37154, not forgetting to return it to 255 when you want keyboard scanning to resume. Once 37154 is set to 127, location 37152 will contain the value 247 when the joystick right switch is open and 119 when the switch is closed. Clearly your program will need to contain a short algorithm to detect when the top right diagonal is called i.e. when top and right switches are closed, or when the bottom right diagonal is called. A short joystick demonstration program is shown in the panel.

The Actual Equipment

Here's a brief technical description of the computer itself and all the add-ons available at the moment.

The VIC20 Colour Computer Specification

5K RAM expandable up to 29K (a further 3K could be added, but this would not be addressable from BASIC).

RS232C interface capability.

8 border colours, 16 screen colours which can be mixed.

8 screen character colours generated directly from the keyboard.

3 audible tone generators, each of 3 octaves.

A white noise generator for sound effects.

22 characters wide by 23 lines deep screen display.

88 character program line length.

64 ASCII character set, upper and lower case alphabetics plus numerics.

Full PET-type graphics character set generated directly from the keyboard.

High resolution graphics capability either directly from defined keyboard characters or via a high resolution graphics cartridge.

176 x 158 pixels (27,808 in total) maximum resolution.

8 programmable special functions accessed via 4 special function keyboard keys.

Automatic repeat on space bar, insert, delete and cursor control keys (other keys can be programmed to repeat).

The console comes complete with a power pack and modulator and the necessary connecting leads and a users' handbook.

Order As AF47B (VIC20 Colour Computer). Price £199.99

VIC C2N Cassette Unit

This cassette unit plugs directly into the computer console and may be used to store your programs. It can also be used to run pre-recorded programs on cassette such as Commodore's 'Teach Yourself Programming.'

Order As AF48C (VIC20 Cassette C2N) Price £44.95

VIC Printer

A tractor-feed 80 character-per-line, 30 characters-per-second printer that plugs directly into the VIC20 console or into the disk drive if that is in use.

Order As AF49D (VIC20 Printer) Price £230.00

VIC Disk Drive

A disk drive that plugs directly into the VIC20 console. The drive may be used with standard single-sided, single density 5¼ inch floppy disks and about 170K bytes of storage is available.

Order As AF50E (VIC20 Disk Drive) Price £396.00

Add-on RAM Cartridges

Any one of these add-on cartridges will plug directly into the VIC20 console. However, if a plug-in ROM cartridge is used, the memory would have to be removed. If you wish to use more than one RAM cartridge or you want to keep the RAM connected when running games, then you will need the Memory Expansion Board described below. The add-on RAM is available in three sizes.

Order As AF51F (VIC 3K RAM) Price £29.95
AF52G (VIC 8K RAM) Price £44.95
AF53H (VIC 16K RAM) Price £74.95

VIC20 Memory Locations

0 to 1023 Working storage RAM (1K)
1024 to 4095 Expansion RAM (3K)
4096 to 7679 User RAM (3.5K)
7680 to 8191 Screen RAM (0.5K)
8192 to 16383 Expansion RAM/ROM (8K)
16384 to 24575 Expansion RAM/ROM (8K)
24576 to 32767 Expansion RAM/ROM (8K)
32768 to 36863 Character ROM (4K)
36864 to 37135 VIC address (0.27K)
37136 to 37887 I/O 1 (0.73K)
37888 to 38911 Colour RAM (1K)
38912 to 39935 I/O 2 (1K)
39936 to 40959 I/O 3 (1K)
40960 to 49151 Expansion ROM (8K)
49152 to 57343 BASIC ROM (8K)
57344 to 65535 Kernal ROM (8K)

Memory Expansion Board

This board plugs directly into the VIC20 console and has four input sockets. Up to four of the following items can be connected: 3K RAM, 8K RAM, 16K RAM, program cartridges, or any IEEE devices such as PET/CBM peripherals.

Order As AF54J (VIC Memory Expansion) Price £125.95

Joysticks and Paddles

A pair of paddles or one joystick may be connected directly to the VIC20 console. (An expander will be available soon to allow two joysticks to be connected, however all the programs available at the moment that use joysticks, require only one). Most of the game cartridges require joysticks, except Super Slot where paddles are required.

Order As AC53H (Single Game Joystick) Price £7.50
AC37S (Pair of Joysticks) Price £13.95
AC45Y (Le Stick) Price £24.95
AC30H (Pair of Paddles) Price £13.95

Programming Aid Cartridges

Three plug-in cartridges for the programmer. Super Expander contains 3K of RAM and enables high resolution graphics up to 176 x 158 pixels to be obtained. Programmers Aid contains additional commands, function key programming and much more. The third cartridge is a machine code monitor.

Order As AC54J (Super Expander) Price £34.95
AC55K (Programmers Aid) Price £34.95
AC56L (Machine Code Monitor) Price £34.95

Introduction to BASIC

Two program cassettes with documentation to help you learn BASIC on the VIC.

Order As AC57M (Intro to BASIC Part 1) Price £14.95
AC58N (Intro To BASIC Part 2) Price £14.95

Game Programs

The following game programs are available on cartridge except for Blitz which is on cassette.

Order As AC59P (VIC Avenger Game) Price £19.95
AC60Q (VIC Star Battle Game) Price £19.95
AC61R (VIC Super Slot Game) Price £19.95
AC62S (VIC Jelly Monsters Game) Price £19.95
AC63T (VIC Alien Game) Price £19.95
AC64U (VIC Super Lander Game) Price £19.95
AC65V (VIC Road Race Game) Price £19.95
AC66W (VIC Rat Race Game) Price £19.95
AC67X (VIC Blitz Game) Price £4.99

Books About VIC

Three books are available to help you really get to know the VIC computer.

Order As WA31J (Learn Programming On The VIC) Price £2.50*NV*
WA32K (VIC Revealed) Price £11.50*NV*
WA33L (VIC Programmers Reference Guide) Price £16.50*NV*

The Future

In our next issue we shall be giving more details about the VIC software. Lots more software will become available later this year. Game programs to be released include Sargon II, Chess, Pinball, Cosmic Jailbreak, Omega Race and Gorf. Adventure programs coming soon include Adventure Land, Treasure Island, Mission Impossible, Voodoo Castle and The Count. Business programs to be released are Simplicalc — a simplified version of Visicalc, Stock Control, File — a data-base handling program, and Letter Writer — a word processor. Also during this year 10 or 11 programs are being released on specific subjects to help with O-level and CSE revision. ■

NEW ITEMS USED IN PROJECTS IN THIS MAGAZINE

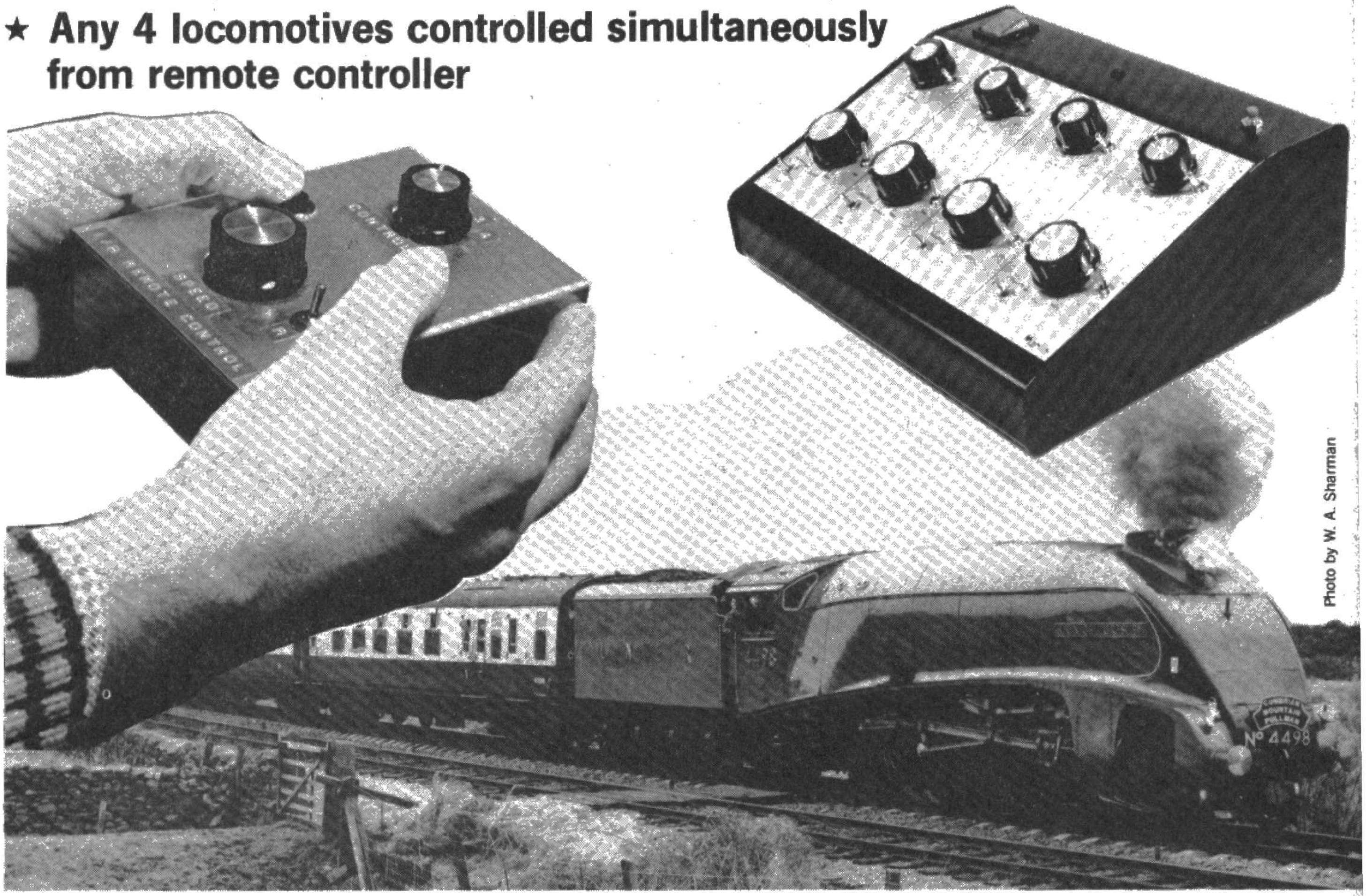
GA65V	Sequencer PSU PCB	**Price £1.35**			
GA71N	Stereo Amp PCB	**Price £4.60**	QY17T	2716/M3	**Price £14.95**
GA78K	Stereo Amp Switchboard	**Price 55p**	RK25C	Stereo Amp Heatsink	**Price £1.25**
GA81C	Channel/PSU PCB	**Price £1.85**	RK26D	Axial 4700uF 40V	**Price £1.40**
GA82D	Extra Channel PCB	**Price £1.35**	RK27E	Adaptor L	**Price 60p**
GA83E	ZX81 Keyboard PCB	**Price £2.95**	RK28F	RA Flexiconnector 5-way	**Price 20p**
GA84F	Remote Data Latch PCB	**Price £2.10**	RK29G	RA Flexiconnector 8-way	**Price 25p**
GA85G	Data Encoder PCB	**Price £2.49**	RK30H	Flexicable 7-way	**Price 54p**
GA86T	Data Decoder PCB	**Price £2.45**	RK31J	Flexicable 10-way	**Price 65p**
GA87U	Infra-red Transmitter PCB	**Price £1.25**	RK32K	Sequencer Key Print	**Price 65p**
GA88V	Infra-red Receiver PCB	**Price £1.25**	XH58N	ZX81 Key Print	**Price 25p**
GA89W	27MHz Transmitter PCB	**Price £1.50**	XG15R	Stereo Amp Chassis	**Price £5.95**
LW66W	Sequencer Kit	**Price £125.00**	XG16S	Stereo Amp Woodwork	**Price £6.25**
LW71N	Stereo Amp Kit	**Price £49.95**	XG17T	ZX81 Keyboard Case	**Price £4.95**
LW72P	ZX81 Keyboard Kit	**Price £19.95**	YQ56L	Sequencer PCB	**Price £4.75**
LW73Q	RTX3 Doppler Kit	**Price £39.95**	YQ57M	Sequencer Display PCB	**Price £1.65**
LW74R	Channel/PSU Kit	**Price £13.95**	YQ58N	Sequencer Keyboard PCB	**Price £2.35**
LW75S	Extra Channel Kit	**Price £4.50**	YQ59P	Sequencer Interface PCB	**Price £2.10**

REMOTE CONTROL

for Digital Multi-Train Controller by Robert Kirsch

★ **Infra-red, radio and wire remote control systems described**

★ **Any 4 locomotives controlled simultaneously from remote controller**



The second in this series of articles on model railway projects describes the addition of remote control facilities to the train controller described in the previous issue. This addition enables any or all of the four control boards to be commanded by an 8-bit digital input either from the remote controller or a computer. The data for each controller is latched and thus one train can be set running and the command changed to another controller to enable up to four trains to be controlled simultaneously by the external input. Figure 1 shows the block schematic diagram of the remote control system.

Additions To Control Board Circuit

Figure 2 shows the complete circuit of the control board with the extra parts added. As described previously, the board works by allowing a group of TS pulses to be sent to the 6 common lines depending on the direction and train to be controlled. The length of this group of pulses determines the speed of the train; thus with no pulses the train is stationary and with a full ten pulses per group, the train is at maximum speed.

In the local mode, the number of pulses in the group is set by selecting one of the ten outputs from the 4017 decade counter (IC1) and using this to trip the output gate after the appropriate number of pulses have been sent. The same applies in the remote mode, except that in this case the output gate is tripped when the output from the binary counter (IC101) is the same as the 4-bit input from the external source. This is detected by the 4-bit magnitude comparator (IC102), The direction in travel in the remote mode is controlled by simply gating the TS pulses fed to the appropriate line

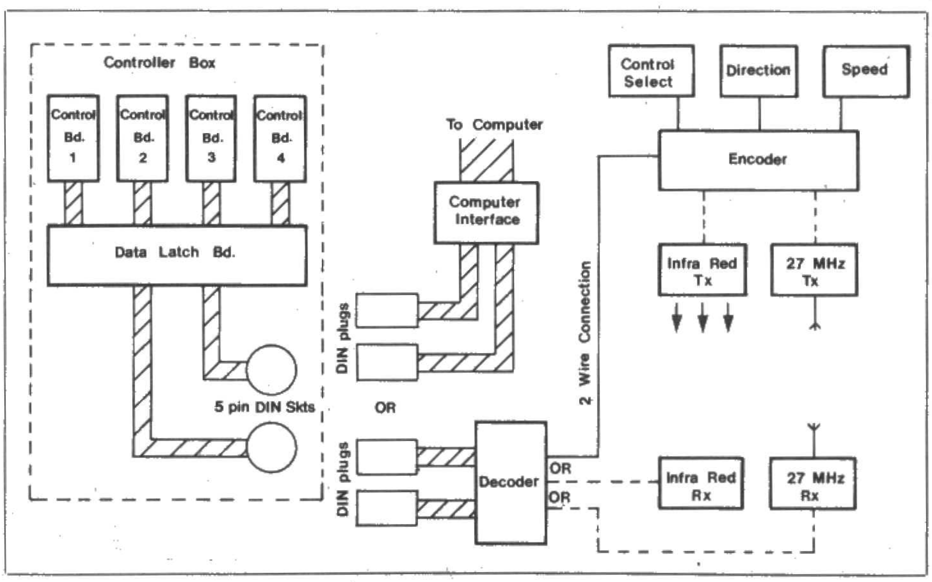


Figure 1. Block schematic showing all options.

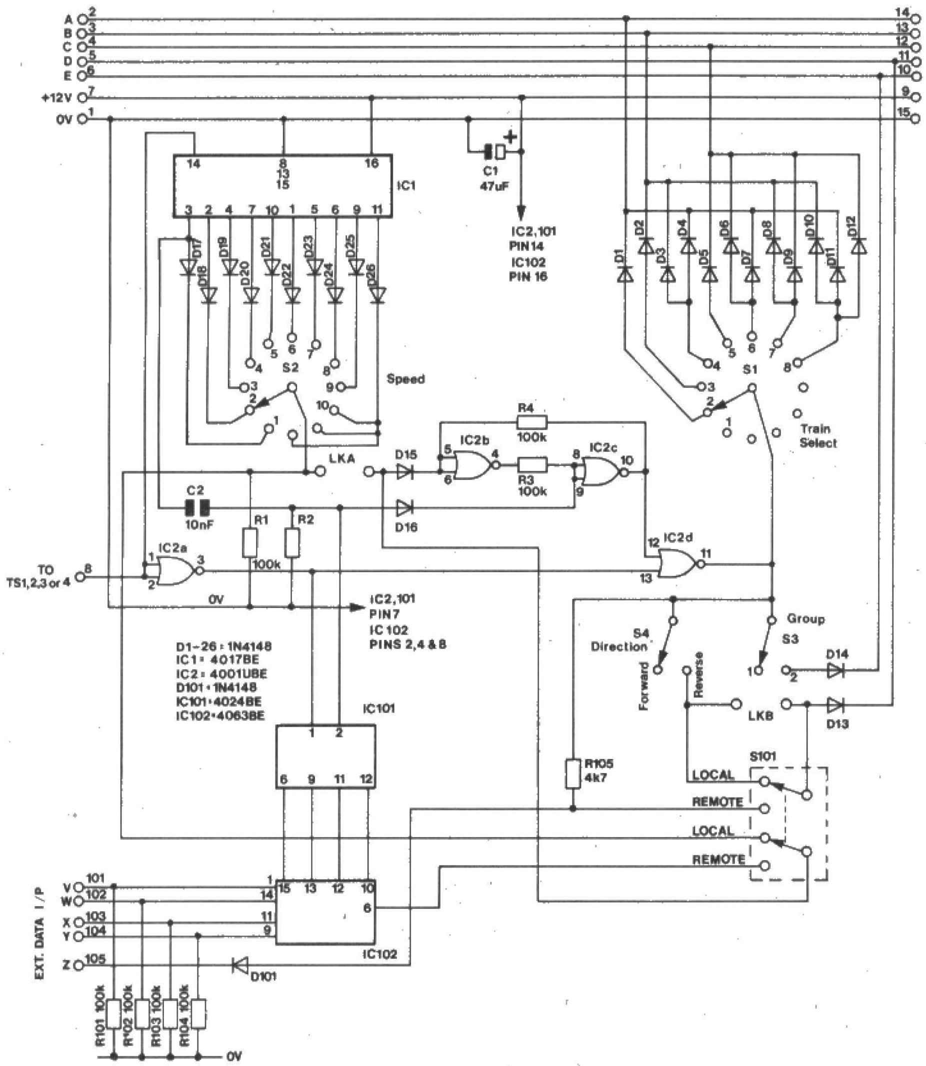


Figure 2a. Circuit diagram of complete Control board.

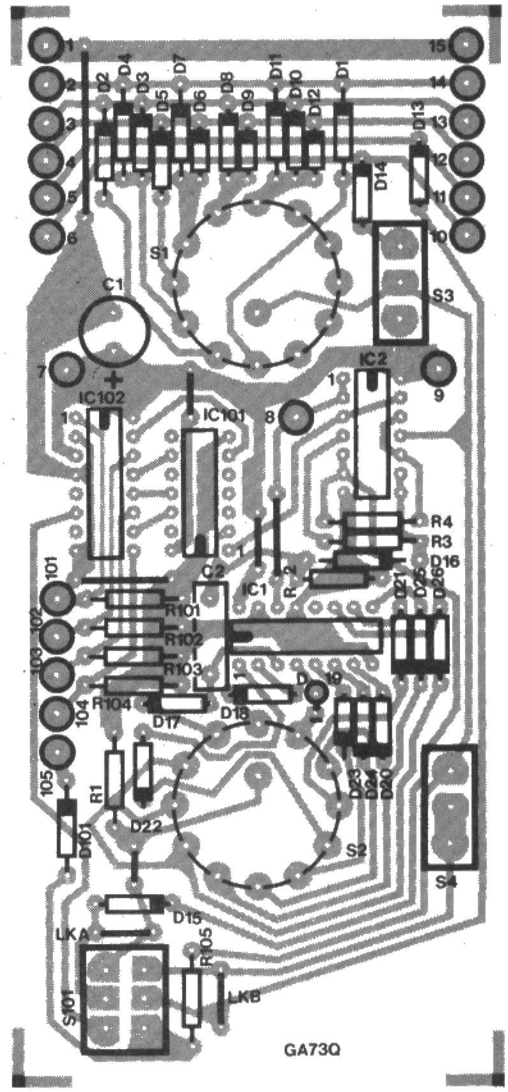
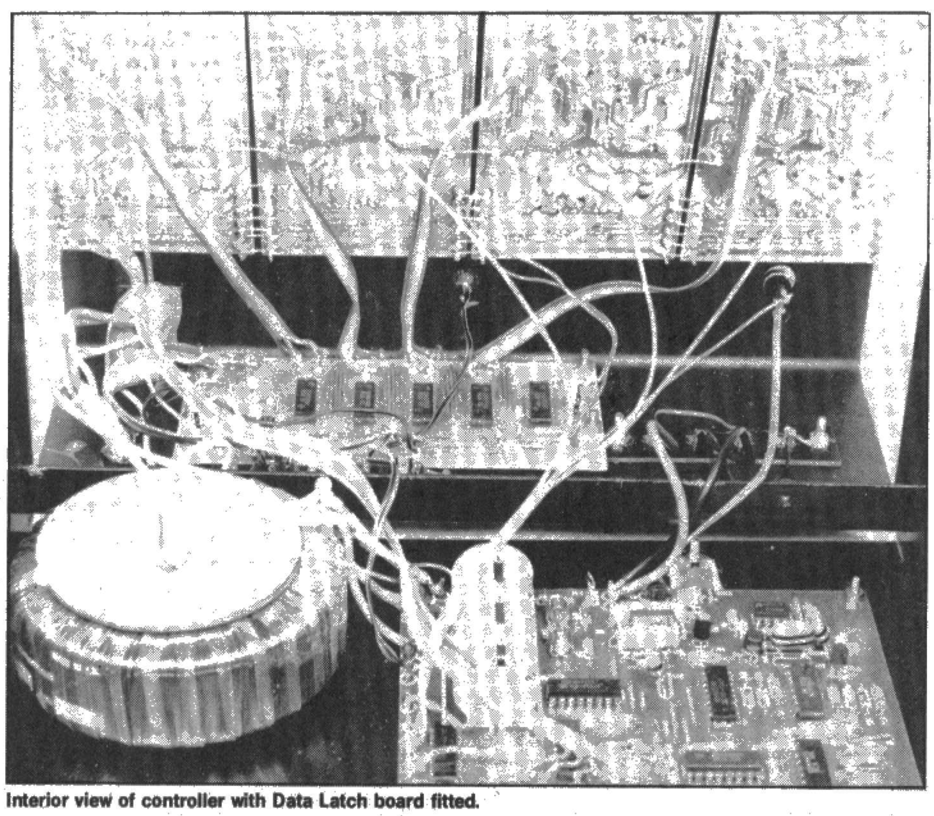


Figure 2b. Component layout of Control board.



Interior view of controller with Data Latch board fitted.

under control of the fifth bit of external data.

Remote Data Latch Board

The data for each of the four control boards is stored by one of the four latches (IC1 to 4); see Figure 3. The control board to be commanded is selected by the conditions applied to the input lines B5 and B6, and this is decoded by IC5 and the diodes D2 to D9 allowing the TS pulse to clock only the required latch.

The eighth bit of the control word may be used for any function required, but we have shown it connected to the power reset circuit. This requires an output only when the button on the remote controller is pressed, so no latch is needed.

Remote Control Data Encoder Board

This board enables any one of the four control boards to be selected and the speed and direction of the train selected by that board to be controlled.

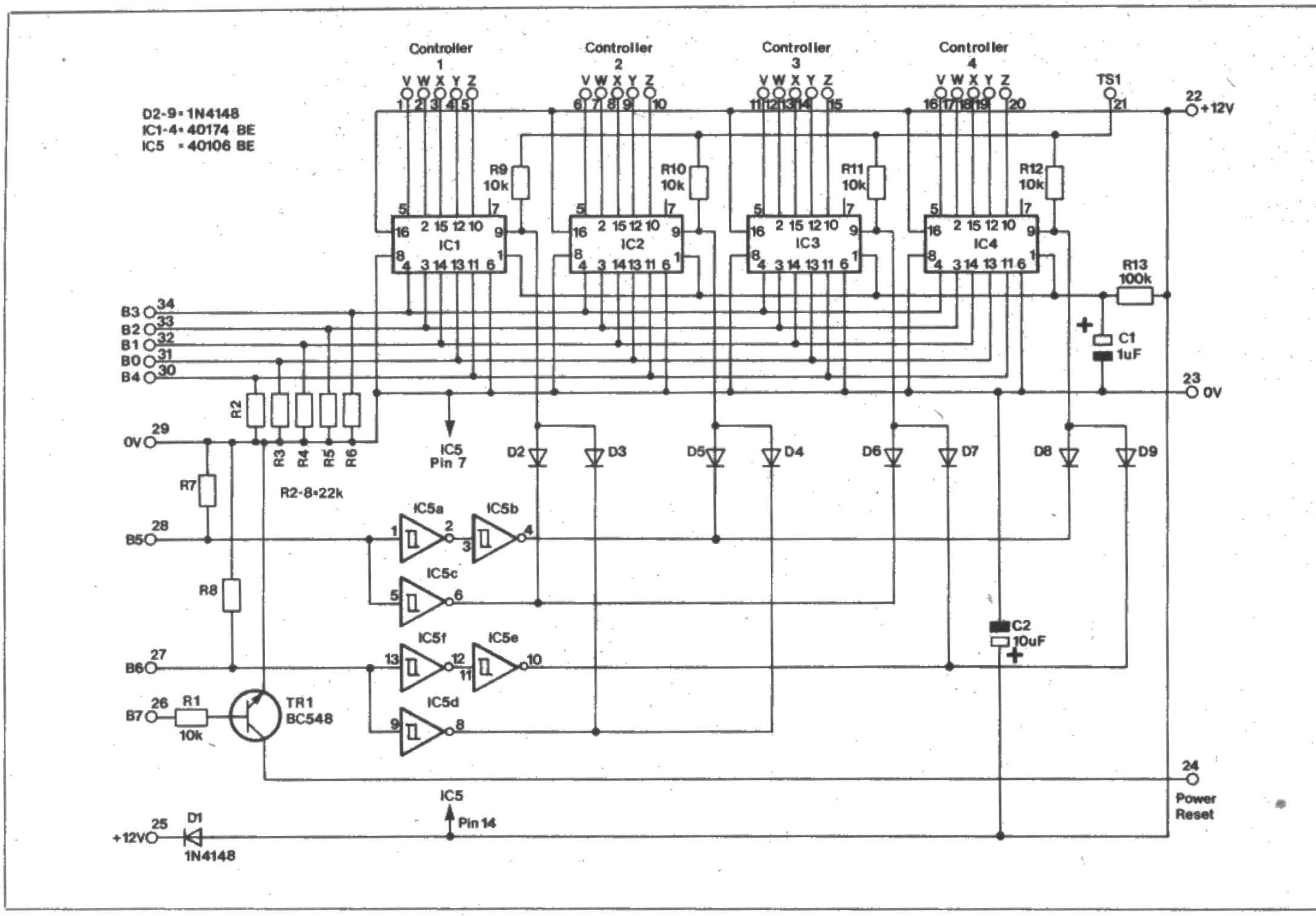


Figure 3a. Circuit diagram of Latch board.

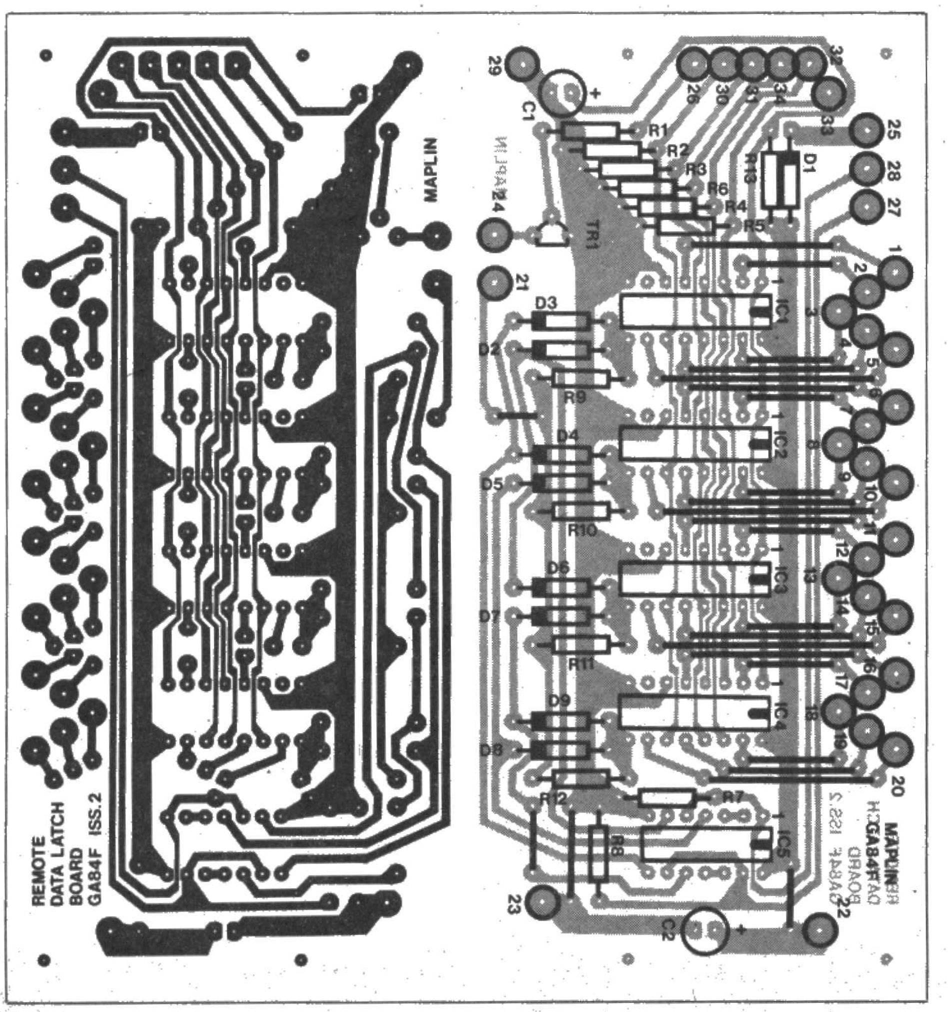


Figure 3b. Component layout of Latch board.

The information is turned into a serial 8-bit word and may be transmitted by radio, wire or infra-red link to the decoder at the train controller.

The serial data sent consists of one long sync pulse followed by eight pulses whose length is determined by whether the bit is at '1' or '0'. A short pulse is sent for 0 and a longer pulse for 1, but a gap is always left between bits to enable the counter in the decoder to step to the next bit.

All the pulses used in the encoder are derived from IC1 (Figure 4) whose mark/space ratio is set to give the critical 'on' period for data '1' transmissions. The output of this IC is fed to the decade counter (IC2) which serves two functions. The first is to select each one of the eight gates (IC3 and IC4) in their correct sequence and at the last two counts, send the sync pulse. The second function of IC2 is to provide sequential pulses to the speed control in decimal form at the same time as the binary counter (IC7) is counting up in binary.

When the decimal count reaches the selected speed, the binary data is clocked into the latch (IC6). The data held in this latch is sent at the appropriate time during the serial word's transmission. A simple diode encoder turns the information from the controller selector into the required two bits to be transmitted. Sync pulses and inter-word gaps are inserted by the gates (IC8) and the output is fed to the emitter follower (TR1).

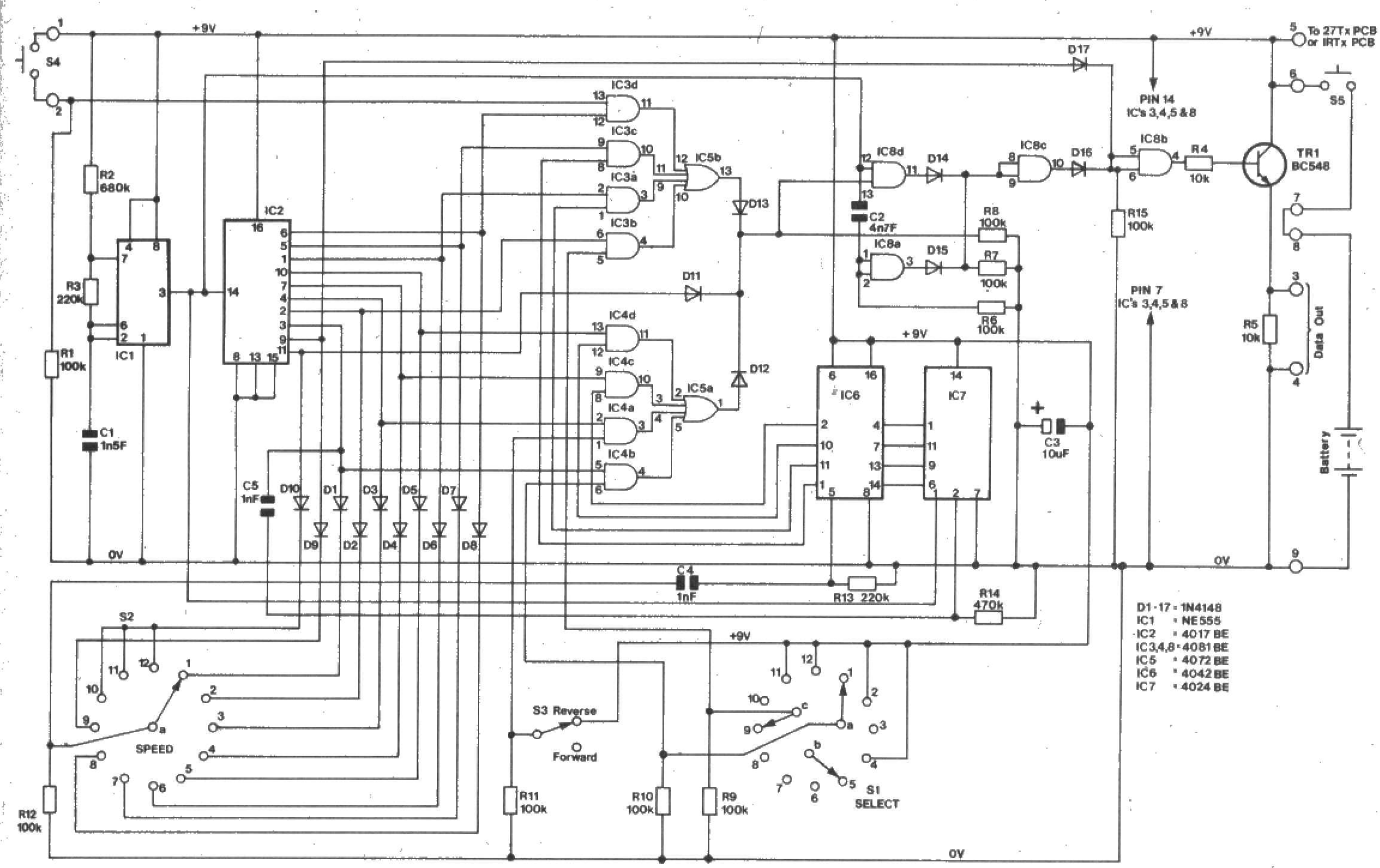


Figure 4a. Circuit diagram of Encoder board.

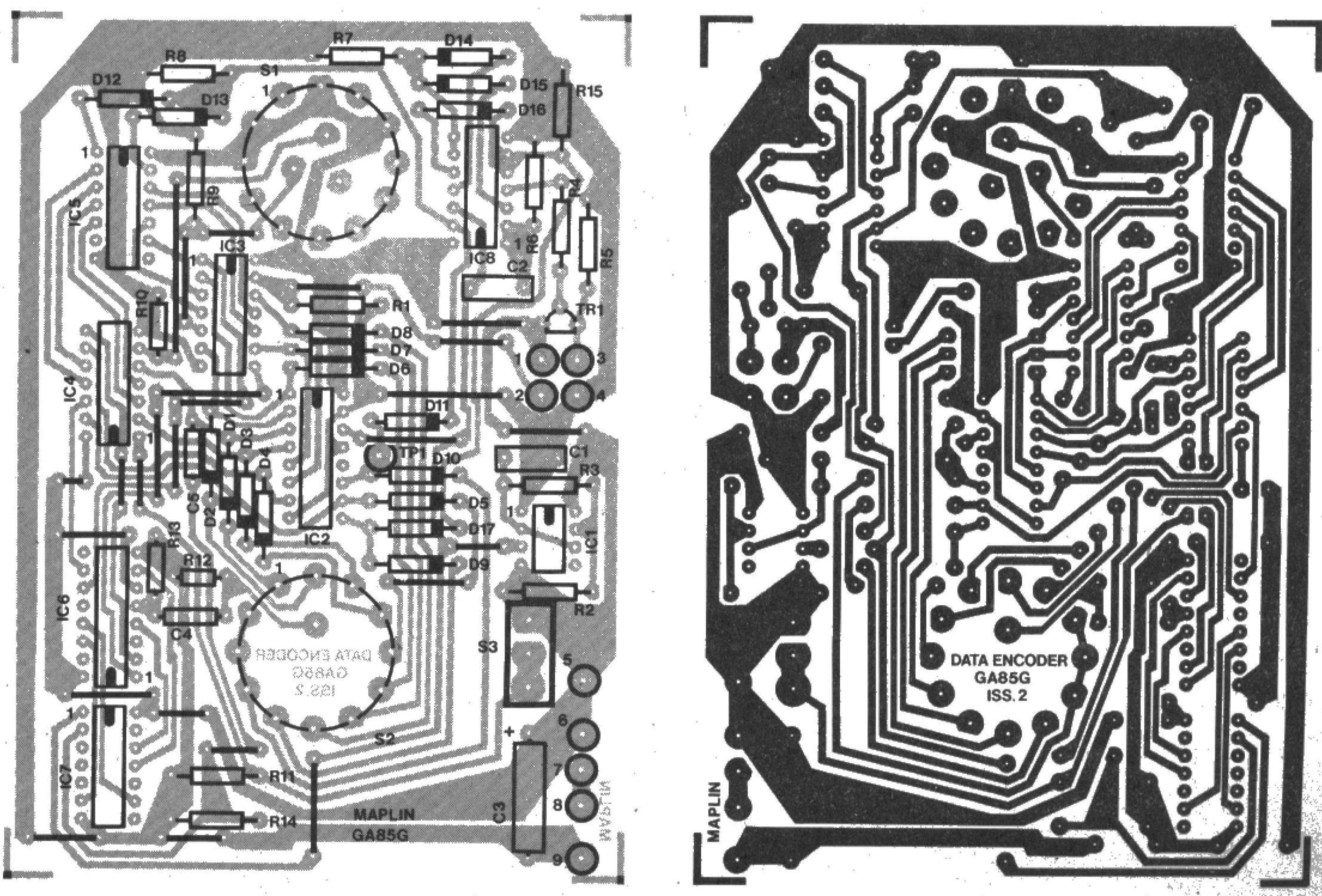


Figure 4b. Component layout of Encoder board.

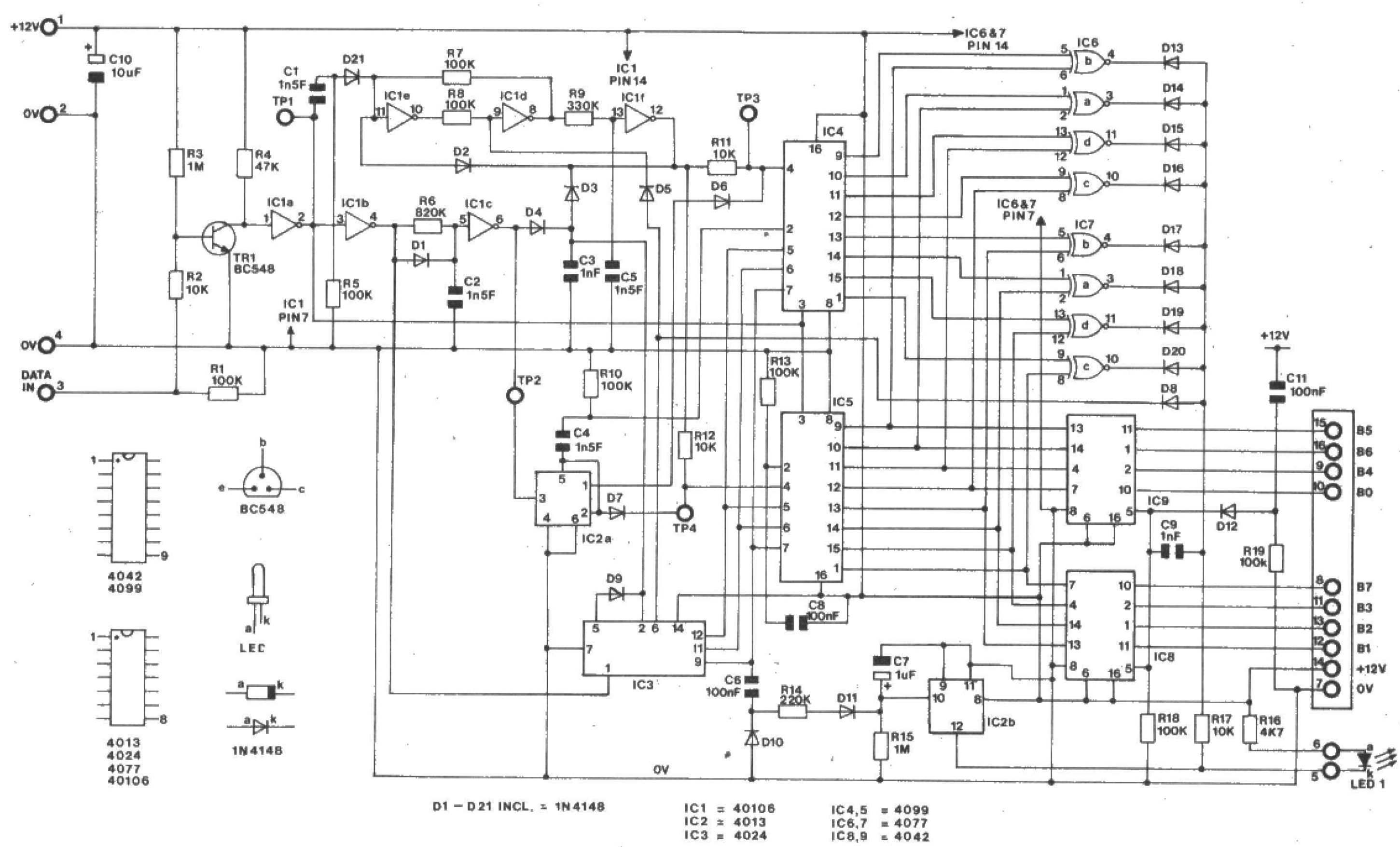


Figure 5a. Circuit diagram of Decoder board.

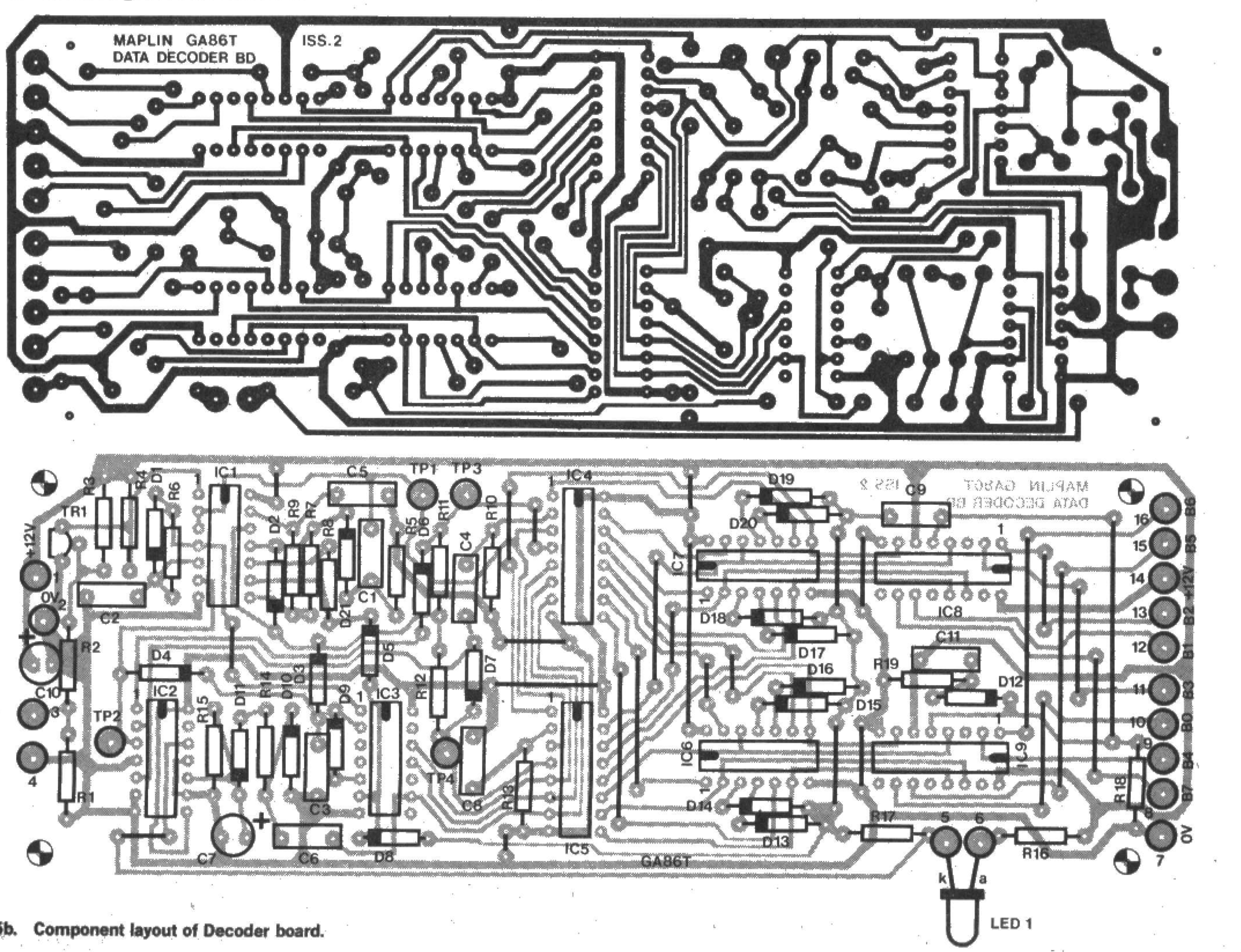
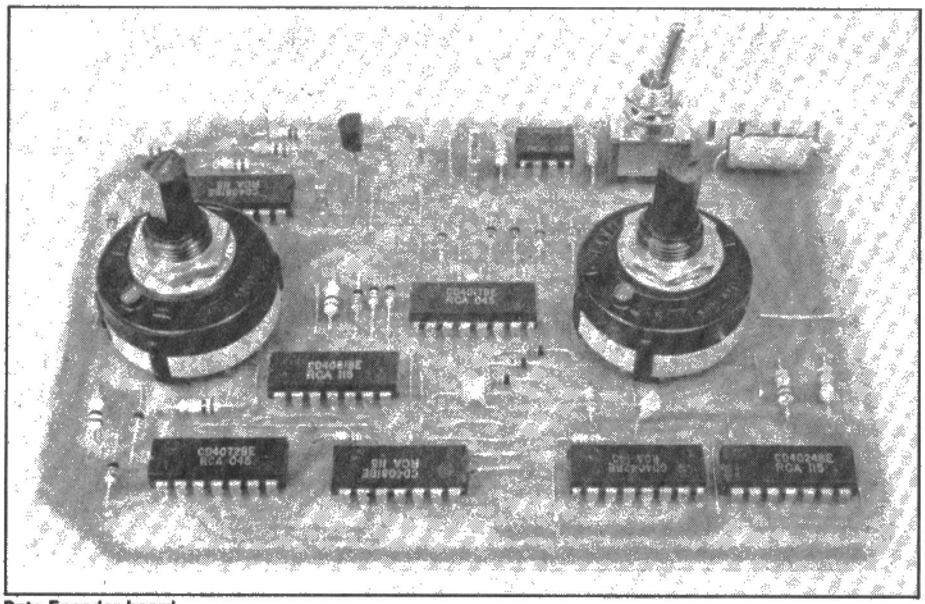
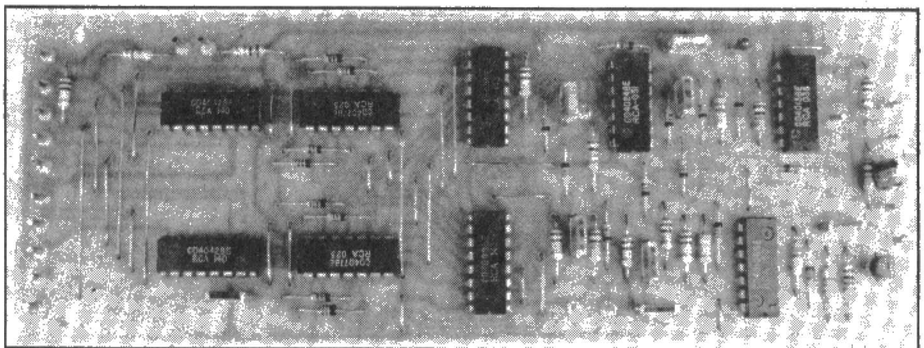


Figure 5b. Component layout of Decoder board.



Data Encoder board.



Data Decoder board.

Remote Control Data Decoder Board

The function of this board is to turn the serial information received from the encoder into a parallel 8-bit word. The system must check that the data received is correct and reject false signals caused by interference. This is done by comparing the data received in one word with the data received in the next word and clocking this data into the output latch only if both words are the same. A detector also monitors the output of the counter and if these pulses are not of the correct timing, the output latches are inhibited and no data transfer can occur.

The incoming signal is first buffered and amplified by TR1 (Figure 5) and then squared and inverted by the Schmitt trigger (IC1A). At this point, the signal should be the same as that leaving the remote encoder.

The signal is now split into three paths. The first is via IC1 B and C which forms a sync detecting unit, giving an output only after the incoming signal has remained at a high condition for the appropriate sync period. This sync pulse is used to reset the binary counter IC3 after it has completed its scan of the addressable latches. This binary counter is stepped by every positive transition of the input signal and its binary output is fed to the two addressable latches (IC4 and IC5); addressing each latch in the same sequence as the incoming bits of the serial signal.

The second path that the input signal can take is via C1. This produces a test pulse, a fixed time after each clocking pulse is received and this is used to enable the selected one of the two addressable latches which are also being fed with incoming data. If the input is high at the time of the test pulse, a '1' is clocked into the addressed latch and if the input is low, a '0' is clocked into the latch.

Each of the two latches is selected alternatively every frame and they are controlled by dividing the sync pulse rate by two in IC2 and using this to inhibit one or other of the latches. At the end of every two frames only one of the latches is cleared back to all low outputs.

The two sets of eight outputs from both latches are compared by the exclusive-NOR gates (IC6 and IC7) and when both latches contain the same data they allow a pulse to clock the data into the two 4-bit output latches (IC8 and IC9). This clock pulse is inhibited if the signal fail detection circuit sees an incorrect input pulse train.

Data Link

There are three methods of connecting the hand-held remote unit to the decoder located at the train controller. The simplest is to use a 2-wire cable which may be connected say, to several sockets located around the layout, to enable the remote unit to be plugged in wherever required.

The second method is by way of a 27MHz radio link and the third via an infra-red link.

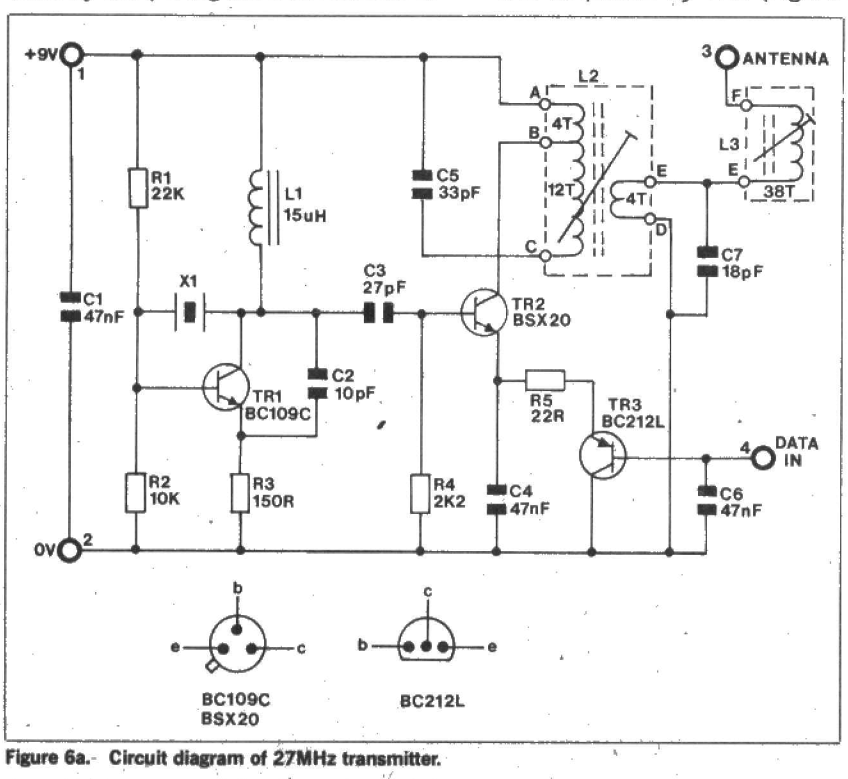


Figure 6a. Circuit diagram of 27MHz transmitter.

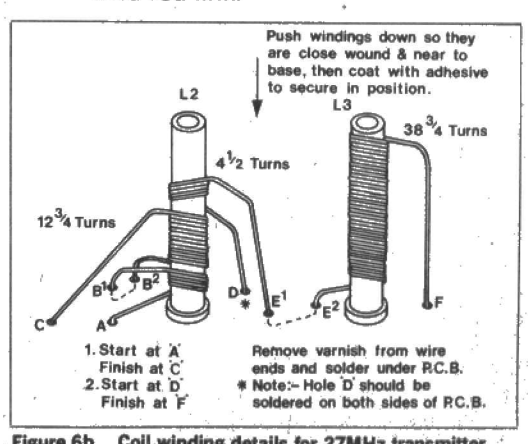


Figure 6b. Coil winding details for 27MHz transmitter.

27MHz Radio Data Link

Transmitter

The transmitter is a low-powered 27MHz crystal-controlled circuit of fairly conventional design. TR1 forms an untuned crystal oscillator which runs all the time that the controller is in operation. The output of this oscillator is fed to the base of TR2 which acts as an output amplifier and modulator. Incoming data is fed to the base of TR3 whose emitter is connected to the emitter of TR2. Thus, when the data is low, TR2 is turned on and passes the rf signal to its collector and the aerial circuit and when the data is high TR2 and TR3 turn off and little or no rf is transmitted.

Receiver

This is built on a standard board designed for model control purposes. Due to the relatively short range required for this application, the rf amplifier in the receiver is not used and is strapped out. This reduces the effect of high levels of external interference. The local oscillator is crystal controlled at 455kHz below the incoming rf frequency and fed to the mixer where it meets the incoming signal from the aerial tuned circuit L1. The 455kHz intermediate frequency is amplified and fed to the detector (D1) via two tuned circuits (IFT1 and IFT2). The signal at the output of the detector is fed via C16 to the data decoder and its DC level is used for controlling the receiver gain (agc).

Licensing Requirements

Please note that a licence is no longer required to transmit and receive signals in the 27MHz band being used for model control. Since the radio link described here meets all the requirements for transmitters and receivers in this band, it is perfectly legal to use it without a licence. Indeed, a licence for this use is simply not available any more.

Infra-Red Data Link

Transmitter

IC1 forms an oscillator running at about 30kHz with a very short, but high amplitude, pulsed output. This output is used to switch TR2 and thus pass high current pulses of about ½A through the four infra-red emitting diodes (D2 to D5) for a very short period. These pulses are turned on and off by TR1 which is controlled by the data input from the encoder.

Receiver

The infra-red signal is received by the diodes D3 and D4 and the 30kHz modulated pulses are amplified by TR1 and TR2. D1 and D2 form a detector and provide a signal relative to the modulation. This signal is amplified by TR3 and any 30kHz is filtered out by its feedback circuit. This signal now feeds TR4 which forms an inverter and output stage.

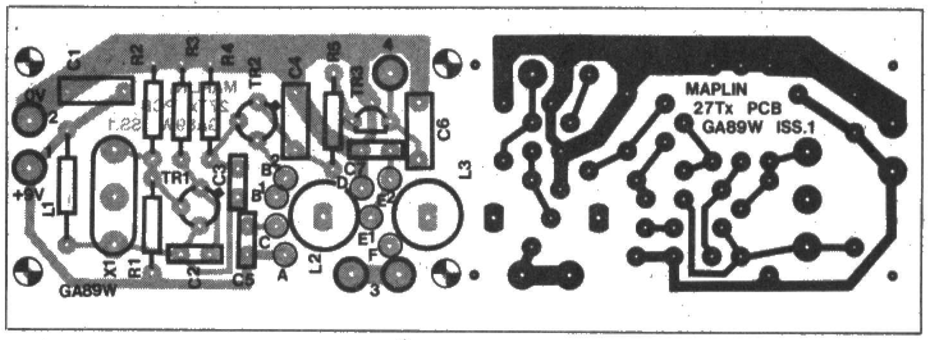
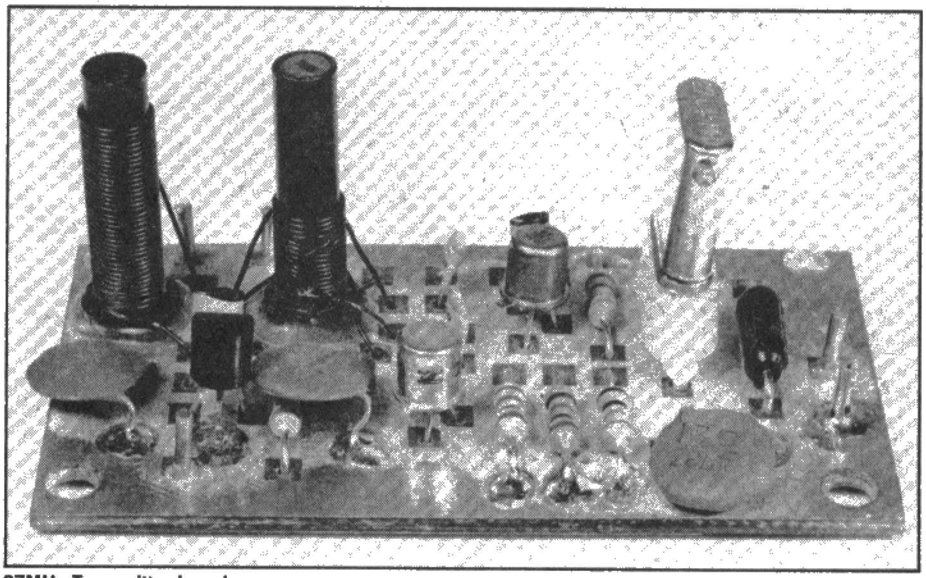


Figure 6c. Component layout of 27MHz transmitter board.



27MHz Transmitter board.

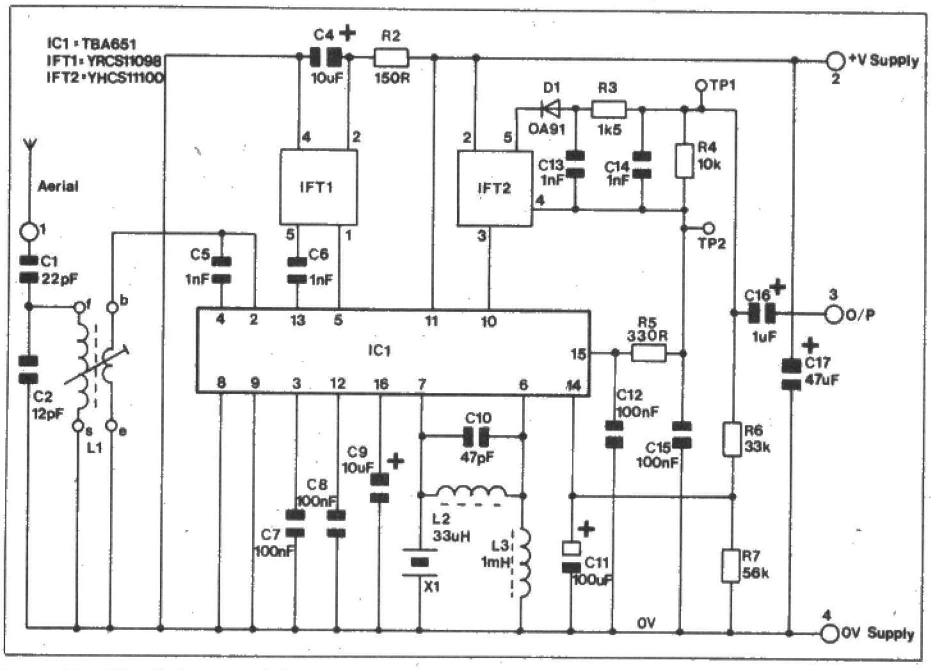


Figure 7a. Circuit diagram of 27MHz receiver.

Construction

Construct all boards referring to the board legend and the appropriate parts list, leaving the insertion of the IC's until last. Refer also to the special instructions below. Add the extra parts to whichever of the control boards you wish to control remotely.

Data Encoder Board

On this board, the Veropins have to be inserted from the component side to aid wiring when the board is mounted in the box. Ensure that the two rotary switches are in the correct positions. S2 is the switch without the click-stops.

27MHz Transmitter Board

This is a double-sided board with an earth-plane on the component side of the board. All the wires should be soldered on both sides of the board except where a clearance hole is provided for component leads on the earth plane side. Insert and glue the two

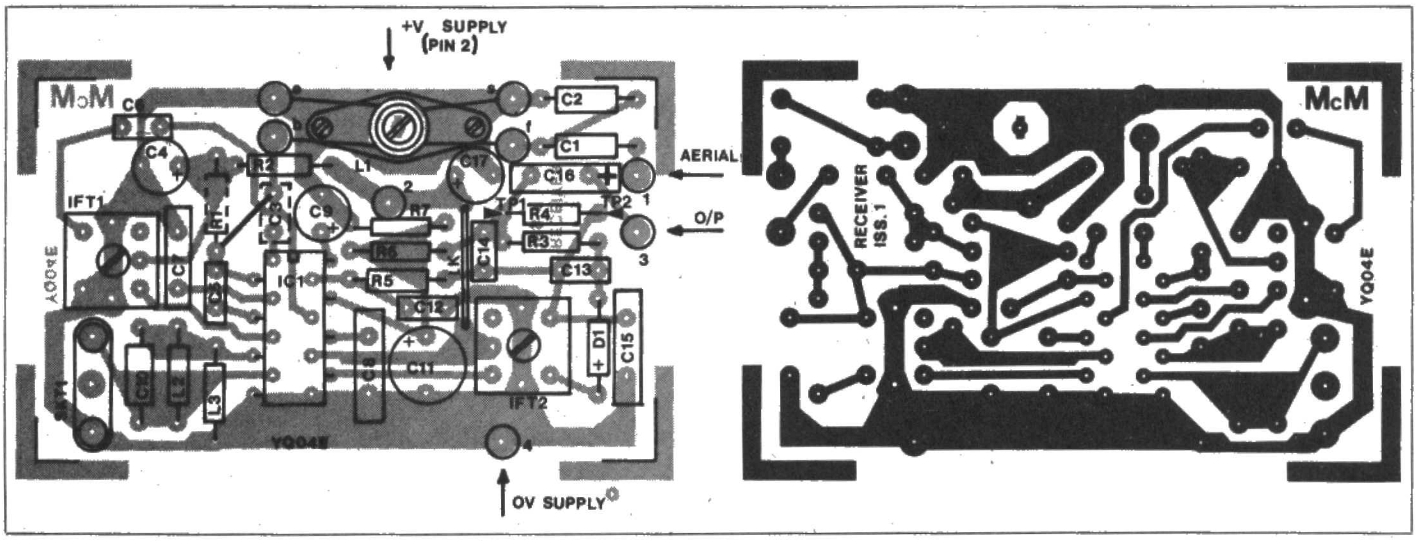
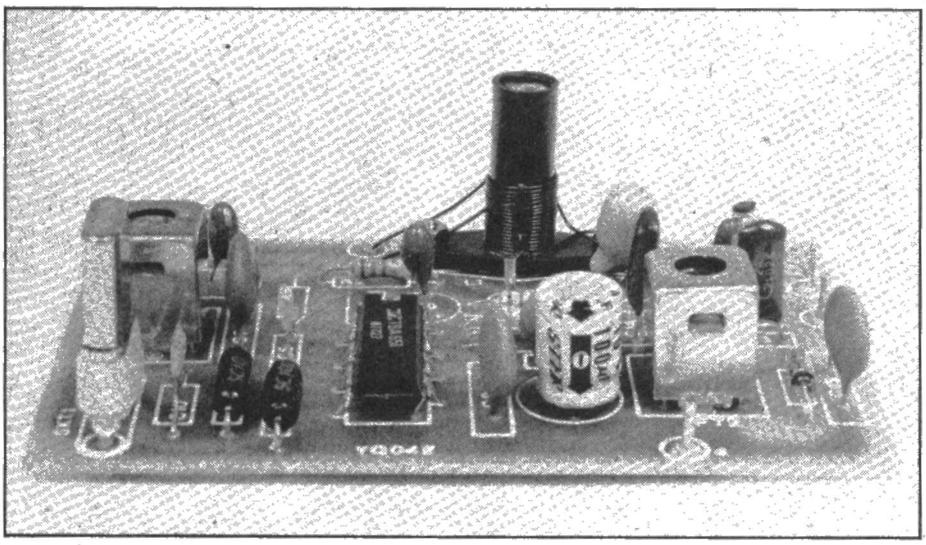


Figure 7b. Component layout of 27MHz receiver board.



27MHz Receiver board.

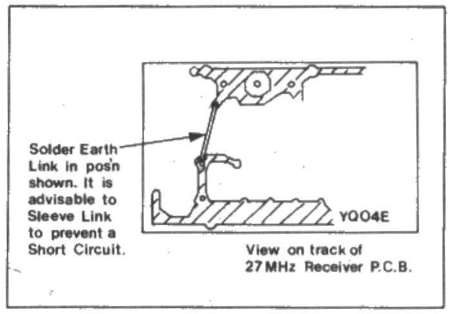


Figure 7c. Addition of earth link to 27MHz receiver board.

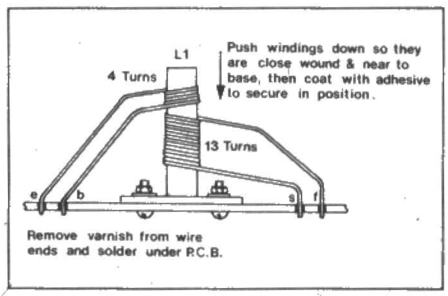


Figure 7d. Coil winding details for 27MHz receiver.

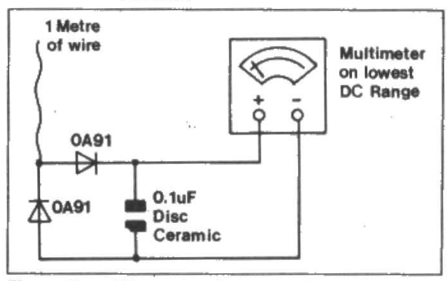


Figure 8a. RF monitor for transmitter alignment.

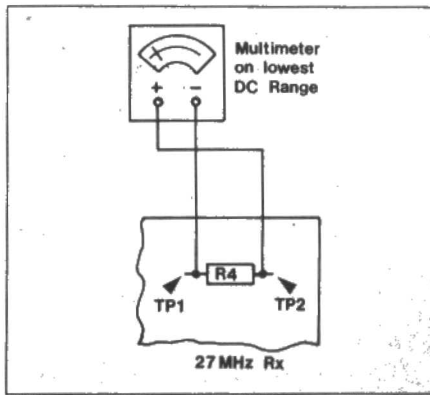


Figure 8b. Meter connections for receiver alignment.

formers for L2 and L3 into the board and wind the coils using 28swg enamelled copper wire referring to Figure 6B.

Start the windings at points A and D and wind up the formers. When the windings are completed they should be fixed with cyanoacrylate adhesive and allowed to dry before setting up the transmitter. The aerial consists of a length of palladium wire about 45cm long connected to pins.

27MHz Receiver Board

Ensure correct positioning of the two i.f. transformers IFT1 and IFT2, and also the two chokes L2 and L3. The positive end of D1 is the end with the band. Note that R1 and C3 are not used in this application and are replaced with a link as shown in Figure 7B. An additional earth strap should be added under the board using a short length of tinned copper wire as shown in Figure 7C.

Wind the coil L1 referring to Figure 7D using 28swg enamelled copper wire. A length of tinned copper wire about 1.5cm long should be soldered to each end of R4 to form TP1 and TP2. The aerial is made from a length of palladium wire about 45cm long connected to pin 1 on the receiver board.

The crystals used in the transmitter and receiver must be a pair, though any colour will do. The crystal with the higher frequency is fitted in the transmitter. The receiver should be sited as far away from the layout as possible in order to reduce electrical interference problems.

Infra-red Receiver

The positioning of the infra-red receiver diodes will affect the range of the system. They should be shielded from direct light both artificial and sunlight. A simple reflector behind the diodes and a lens system will improve the range. Nevertheless, a range of about 6 metres can be expected with no additions with the transmitter pointing directly at the receiver diodes. The receiver must be mounted in a metal box with the box connected to 0V, otherwise the very sensitive circuit will pick up radio interference.

Setting-up 27MHz Transmitter & Receiver

Transmitter

Construct the rf monitor as shown in Figure 8a and connect to a suitable

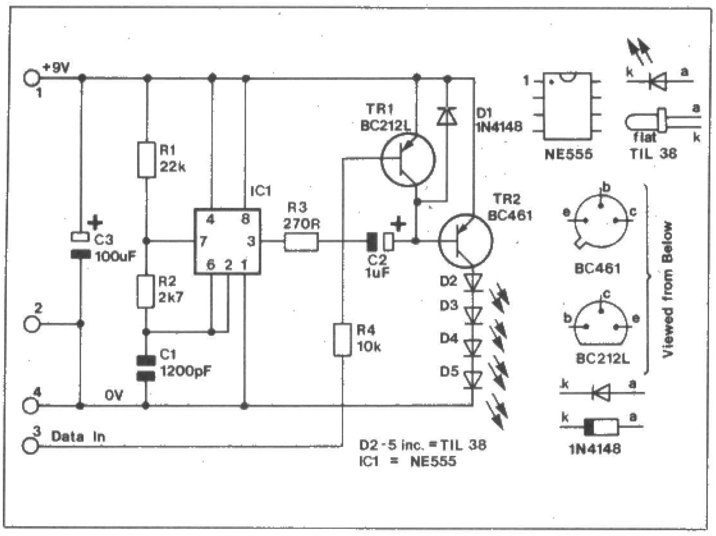


Figure 9a. Circuit diagram of Infra-red transmitter.

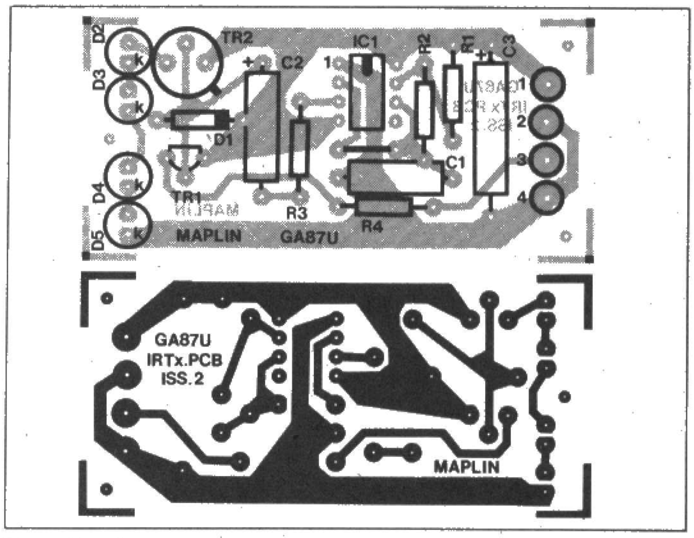
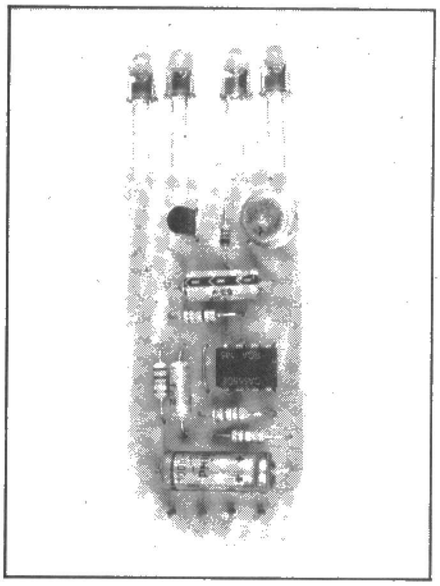


Figure 9b. Component layout of Infra-red transmitter board.



Infra-red Transmitter board.

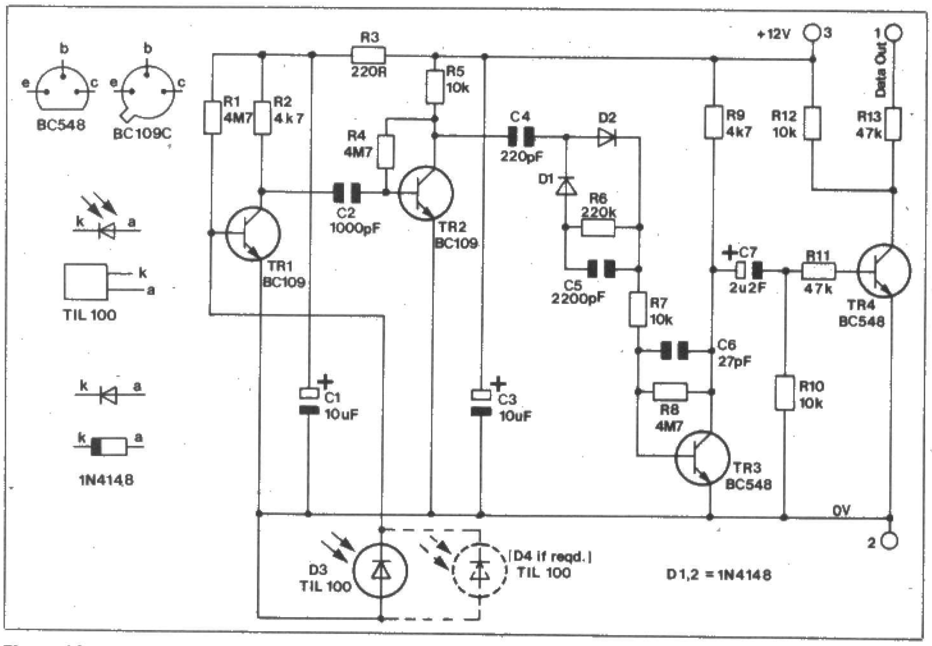


Figure 10a. Circuit diagram of Infra-red receiver.

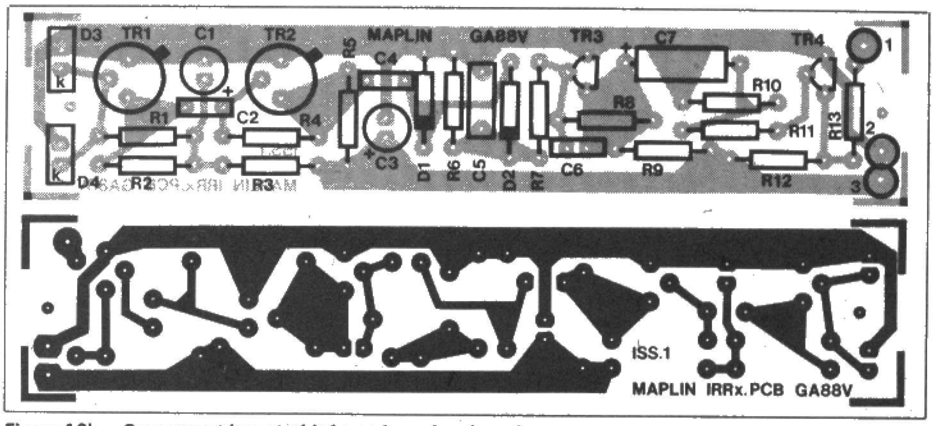


Figure 10b. Component layout of Infra-red receiver board.

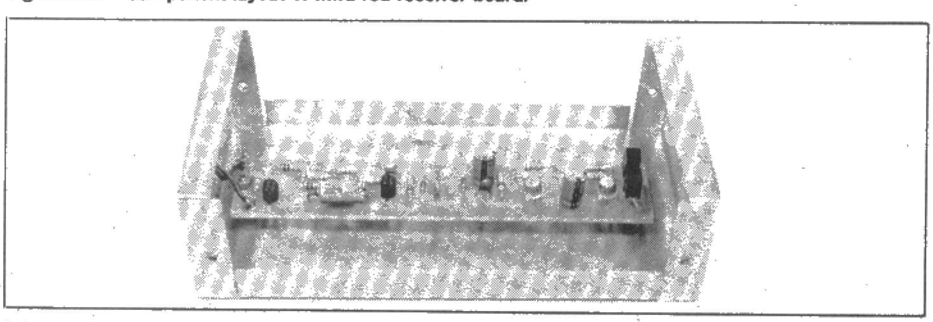
meter. Install the battery in the hand-held controller and hold the aerial near the wire attached to the monitor. When the transmit button is pressed, a reading should be obtained on the meter. Adjust L2 for maximum reading.

Move the aerial away from the monitor wire until a reading is just present and adjust L3 for maximum reading. Keep moving the aerial further away until a peak setting is found at the greatest distance away from the monitor wire. The controller should be held in a position as near as possible to that in which it will be used during the setting up of L3 to obtain maximum output under working conditions.

Receiver

Connect the receiver to the train controller and connect a suitable meter to TP1 and TP2 (Figure 8b) on the receiver board. Temporarily short out the transmit push button on the hand-held unit in order to provide a continuous transmitted signal. A reading should be obtained on the meter when the hand-held unit is brought near the receiver aerial.

Move the transmitter away until the reading on the meter falls and then adjust L1, T1 and T2 in turn for



Infra-red Receiver board.

CONTROL CODE CHART							
	SPEED	DIRECTION	CODE No.		SPEED	DIRECTION	CODE No.
CONTROL BD. 1	0 ↓ 10	Forward	0 ↓ 10	CONTROL BD. 2	0 ↓ 10	Forward	32 ↓ 42
	0 ↓ 10	Reverse	16 ↓ 26		0 ↓ 10	Reverse	48 ↓ 58
CONTROL BD. 3	0 ↓ 10	Forward	64 ↓ 74	CONTROL BD. 4	0 ↓ 10	Forward	96 ↓ 106
	0 ↓ 10	Reverse	80 ↓ 90		0 ↓ 10	Reverse	112 ↓ 122

Figure 11. Table of decimal codes for control functions.

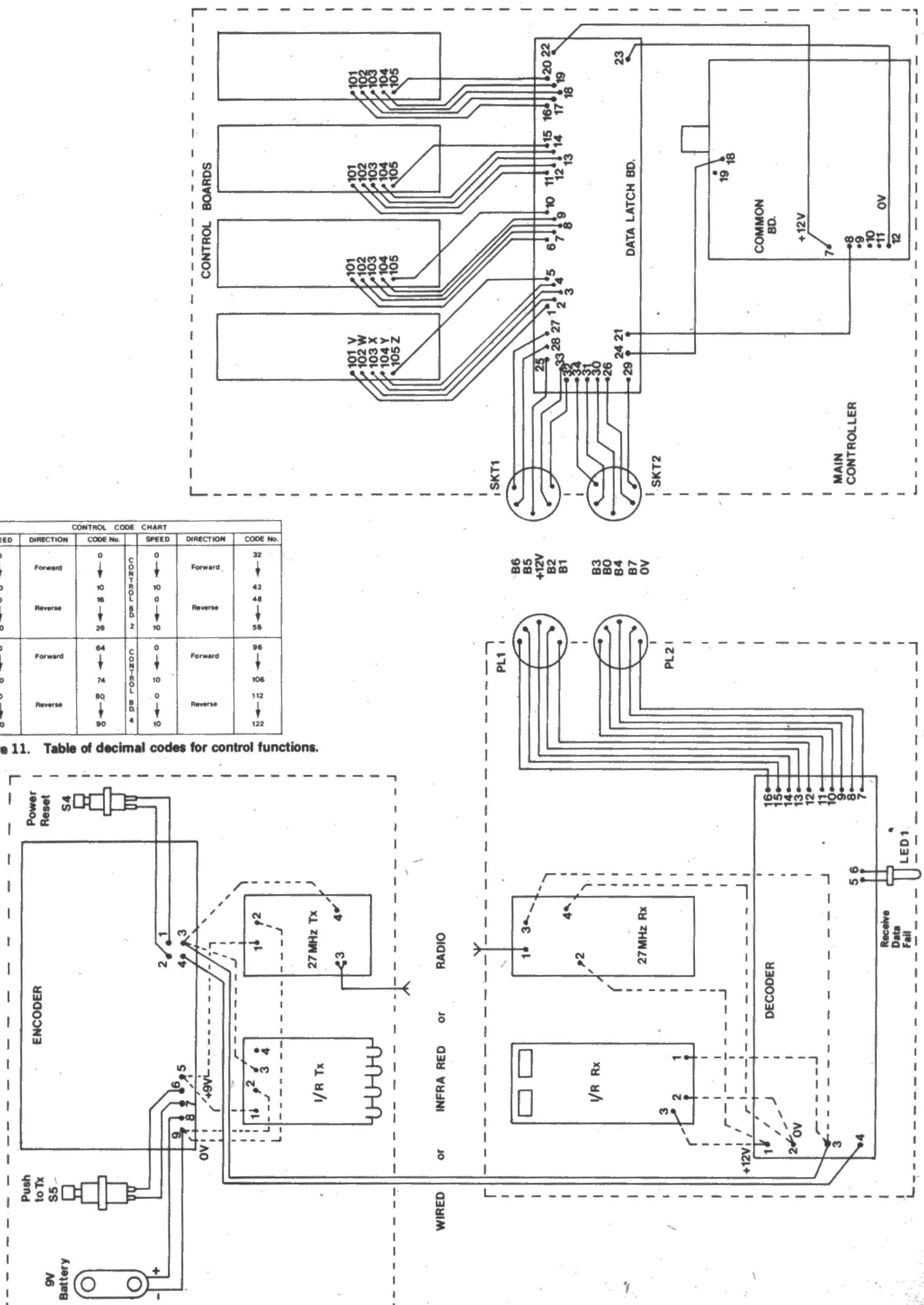


Figure 12. Interwiring diagram.

maximum reading. Keep moving the hand-held unit further away and retuning the receiver until a maximum reading is obtained at the greatest distance. A good reading should be obtained with the transmitter at least 7 metres away from the receiver. Disconnect the temporary link on the transmitter and the system should now be ready for use.

Remote Control Operation

Select the train or trains to be controlled on the train controller and switch the appropriate control boards to 'Remote'. The control board to be commanded may now be selected on the remote unit. Press the transmit button and set the speed and direction of the train as required. Note that there is a short delay of about 1 second before the decoder decides a valid signal is being received, but after this initial delay all information is transferred immediately.

The selected train may be left running and another controlled by first releasing the transmit button and then selecting the next train, pressing the transmit button and controlling the speed and direction of the new train. This process can be repeated until all four control boards are in use.

In the event of the power protection circuit being tripped, it may be reset by first pressing the transmit button, then pressing the reset button on the hand-held unit. This facility may also be used as an emergency stop by releasing the transmit button before the reset button. The power will remain off until a new command is sent. Note that this condition overrides the manual reset control on the train controller, but it may be reset from that end by turning the mains switch off for about 10 seconds before re-applying power.

When using the 27MHz link it should be noted that there is a minimum distance of about 2 metres where the transmitter will overload the receiver and no data will be transferred.

Computer Control

The 8-bit digital input may be fed from any computer via a suitable interface unit. An interface for the ZX81 will be described in our next issue. If the binary word required to control the system is converted into decimal form, programming is accomplished as follows.

The starting number for each of the four control boards is:

0 for Control Board 1
32 for Control Board 2
64 for Control Board 3
and 96 for Control Board 4

To control the forward speed of each board, add a number from 0 to 10 inclusive to the starting number. Zero is minimum speed and 10 is maximum speed. For the reverse direction, add 16 to the starting number and then add a further 0 to 10 to control the speed.

Power reset or 'all stop' may be accomplished by using the number 128. Note that as each train is controlled, the last data sent for that train is held in the associated latch, so to stop all trains, it is necessary to enter the four numbers 0, 32, 64 and 96. It does not matter in which direction the trains are travelling at the time the command is given.

The inertia or speed-up and slow-down rate of each train may be written into the program by arranging for the time taken to step up from zero to the required speed and back to zero to be varied. By using the input ports, the train controller can be made to control the speed of the train dependent on its position on the layout. Future articles will describe suitable detectors and interfacing for this and computer control of signals and points.

PARTS LIST OF ADDITIONS TO CONTROL BOARD FOR REMOTE CONTROL OR COMPUTER CONTROL (1)

Resistors — all ¼W 5% carbon			
R101 to 104	100k	4 off	(M100K)
R105	4k7		(M4K7)
Semiconductors			
D101	1N4148		(QL80B)
IC101	4024BE		(QX13P)
IC102	4063BE		(QW41U)
Miscellaneous			
S101	Sub-min toggle 2-pole		(FH04C)
	Veropin 2141	5 off	(FL21X)

Note: Links 'A' and 'B' must be removed from pcb.

DATA LATCH PARTS LIST (2)

Resistors — all ¼W 5% carbon			
R1,9 to 12	10k	5 off	(M10K)
R2 to 8	22k	7 off	(M22K)
R13	100k		(M100K)
Capacitors			
C1	1uF 100V pc electrolytic		(FF01B)
C2	10uF 35V pc electrolytic		(FF04E)
Semiconductors			
D1 to 9	1N4148	9 off	(QL80B)
TR1	BC548		(QB73Q)
IC1 to 4	40174BE		(QW73Q)
IC5	40106BE		(QW64U)
Miscellaneous			
SK1	DIN socket 5-pin A		(HH34M)
SK2	DIN socket 5-pin B		(HH35Q)
	Remote data latch pcb		(GA84F)
	Veropin 2141	34 off	(FL21X)

27MHz DATA RECEIVER PARTS LIST (8)

Resistors — all ¼W 5% carbon			
R1	Not used		
R2	150R		(M150R)
R3	1k5		(M1K5)
R4	10k		(M10K)
R5	330R		(M330R)
R6	33k		(M33K)
R7	56k		(M56K)
Capacitors			
C1	22pF ceramic		(WX48C)
C2	12pF ceramic		(WX45Y)
C3	Not used		
C4,9	10uF 16V tantalum	2 off	(WW68Y)
C5,6	1nF ceramic	2 off	(WX68Y)
C7,8,12,15	100nF disc ceramic	4 off	(BX03D)
C10	47pF ceramic		(WX52G)
C11	100uF 10V pc electrolytic		(FF10L)
C13,14	1nF mylar	2 off	(WW15R)
C16	1uF 35V tantalum		(WW60Q)
C17	47uF 10V tantalum		(WW75S)
Semiconductors			
D1	OA91		(QH72P)
IC1	TBA651		(BL35Q)
Miscellaneous			
L1	Former 351		(LB17T)
	Dust core type 6		(LB42V)
	Enamelled copper wire 28swg		(BL39N)
L2	Choke 33uH		(WH38R)
L3	Choke 1mH		(WH47B)
IFT1	YRCS 11098		(HX42V)
IFT2	YHCS11100		(HX43W)
X1	Crystal		(see transmitter)
SKT1	Crystal socket		(HX60Q)
	Bolt 8BA ¼in.	2 off	(BF08J)
	Nut 8BA	2 off	(BF19V)
	Washer 8BA	2 off	(BF23A)
	27MHz receiver pcb		(YQ04E)

DATA DECODER PARTS LIST (3)

Resistors — all ¼W 5% carbon

R1,7,8,10,13,18,19	100k	7 off	(M100K)
R2,11,12,17	10k	4 off	(M10K)
R3,15	1M	2 off	(M1M)
R4,5	47k	2 off	(M47K)
R6	820k		(M820K)
R9	330k		(M330K)
R14	220k		(M220K)
R16	820R		(M820R)

Capacitors

C1,2,4,5	1.5nF polycarbonate	4 off	(WW23A)
C3,9	1nF polycarbonate	2 off	(WW22Y)
C6,8,11	100nF polycarbonate	3 off	(WW41U)
C7	1uF 35V tantalum		(WW60Q)
C10	10uF 35V pc electrolytic		(FF04E)

Semiconductors

D1 to 21	1N4148	21 off	(QL80B)
LED1	Red LED		(WL27E)
TR1	BC548		(QB73Q)
IC1	40106BE		(QW64U)
IC2	4013BE		(QX07H)
IC3	4024BE		(QX13P)
IC4,5	4099BE	2 off	(QW57M)
IC6,7	4077BE	2 off	(QW47B)
IC8,9	4042BE	2 off	(QX19V)

Miscellaneous

PL1	DIN plug 5-pin A		(HH27E)
PL2	DIN plug 5-pin B		(HH28F)
	Data decoder pcb		(GA86T)
	Veropin 2141	20 off	(FL21X)

DATA ENCODER PARTS LIST (4)

Resistors — all ¼W 5% carbon unless specified

R1,6,7,8,9,11,15	100k	7 off	(M100K)
R2	680k		(M680K)
R3	220k		(M220K)
R4,5*	10k	2 off	(M10K)
R10,12	100k (½W)	2 off	(U100K)
R13	220k (½W)		(U220K)
R14	470k		(M470K)

Capacitors

C1	1.5nF polycarbonate		(WW23A)
C2	4.7nF polycarbonate		(WW26D)
C3	10uF 25V axial electrolytic		(FB22Y)
C4,5	1nF ceramic	2 off	(WX68Y)

Semiconductors

D1 to 17	1N4148	17 off	(QL80B)
TR1	BC548		(QB73Q)
IC1	NE555		(QH66W)
IC2	4017BE		(QX09K)
IC3,4,8	4081BE	3 off	(QW48C)
IC5	4072BE		(QX27E)
IC6	4042BE		(QX19V)
IC7	4024BE		(QX13P)

Miscellaneous

S1	Rotary switch 3 pole 4 way		(FH44X)
S2	Switchpot 1 pole 12 way		(XX45Y)
S3	Sub-min toggle 'A'		(FH00A)
S4	Push switch		(FH59P)
S5	Press switch		(FH91Y)
	Knob K7B (for S1)		(YX02C)
	Knob K7C (for S2)		(YX03D)
	Battery clip		(HF28F)
	PP3 battery		—
	Data encoder pcb		(GA85G)
	Veropin 2141	10 off	(FL21X)

*If this is to be used with the 27MHz data link then make R5 a Min Res 1k even if you are using IR or wired links as well.

To make the function shown below, you will require all the parts shown in the parts list indicated.

Computer interface : 1, 2.
Wired remote control : 1, 2, 3, 4.
Infra-red remote control : 1, 2, 3, 4, 5, 6.
Radio remote control : 1, 2, 3, 4, 7, 8.

Note that parts list 1 will be required for each control board that you wish to modify.

As there are so many possible different combinations of these parts, it is not possible to offer kits.

INFRA-RED TRANSMITTER PARTS LIST (5)

Resistors — all ¼W 5% carbon

R1	22k		(M22K)
R2	2k7		(M2K7)
R3	270R		(M270R)
R4	10k		(M10K)

Capacitors

C1	1200pF 1% polystyrene		(BX57M)
C2	1uF 63V axial electrolytic		(FB12N)
C3	100uF 10V axial electrolytic		(FB48C)

Semiconductors

D1	1N4148		(QL80B)
D2 to 5	TIL38	4 off	(YH70M)
TR1	BC212L		(QB60Q)
TR2	BC461		(QB72P)
IC1	NE555		(QH66W)

Miscellaneous

	Infra-red transmitter pcb		(GA87U)
	Veropin 2141	4 off	(FL21X)

INFRA-RED RECEIVER PARTS LIST (6)

Resistors — all ¼W 5% carbon

R1,4,8	4M7	3 off	(M4M7)
R2,9	4k7	2 off	(M4K7)
R3	220R		(M220R)
R5,7,10,12	10k	4 off	(M10K)
R6	220k		(M220K)
R11,13	47k	2 off	(M47K)

Capacitors

C1,3	10uF 35V pc electrolytic	2 off	(FF04E)
C2	1000pF ceramic		(WX68Y)
C4	220pF ceramic		(WX60Q)
C5	2200pF polycarbonate		(WW24B)
C6	27pF ceramic		(WX49D)
C7	2.2uF 63V axial electrolytic		(FB15R)
C8	100nF 35V tantalum		(WW54J)

Semiconductors

D1,2	1N4148	2 off	(QL80B)
D3 (D4 if req'd)	TIL100		(YH71N)
TR1,2	BC109C	2 off	(QB33L)
TR3,4	BC548	2 off	(QB73Q)

Miscellaneous

	Infra-red receiver pcb		(GA88V)
	Veropin 2141	3 off	(FL21X)

27MHz DATA TRANSMITTER PARTS LIST (7)

Resistors — all ¼W 5% carbon

R1	22k		(M22K)
R2	10k		(M10K)
R3	150R		(M150R)
R4	2k2		(M2K2)
R5	22R		(M22R)

Capacitors

C1,4,6	47nF disc ceramic	3 off	(BX02C)
C2	10pF ceramic		(WX44X)
C3	27pF ceramic		(WX49D)
C5	33pF ceramic		(WX50E)
C7	18pF ceramic		(WX47B)

Semiconductors

TR1	BC109C		(QB33L)
TR2	BSX20		(QF32K)
TR3	BC212L		(QB60Q)

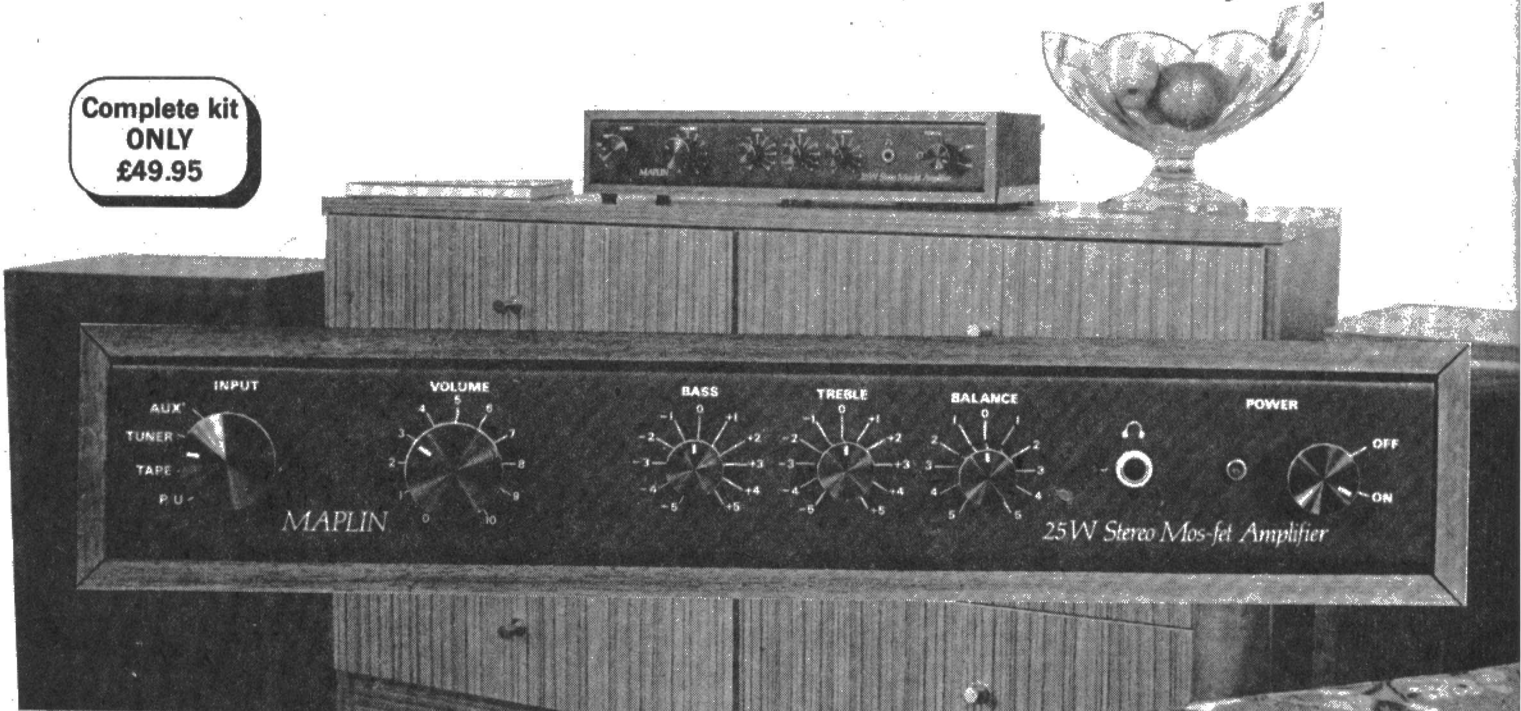
Miscellaneous

L1	Choke 15uH		(WH36P)
L2,3	Former 722/2	2 off	(LB20W)
	Dust Core	2 off	(LB41U)
	Enamelled copper wire 28swg	½m	(BL39N)
X1	Crystal (supplied in pairs) (any one of HX30H to HX35Q)		
	Crystal socket		(HX60Q)
	27MHz transmitter pcb		(GA89W)
	Veropin 2141	3 off	(FL21X)

25W STEREO MOS~FET HI~FI AMPLIFIER

by Dave Goodman

Complete kit ONLY £49.95



- ★ **25W per channel rms with power MOSFET output**
- ★ **Very easy to build — only 7 interconnecting wires**
- ★ **Extremely low total harmonic distortion**
- ★ **Extremely low noise**
- ★ **High efficiency toroidal transformer**
- ★ **Complete kit includes wooden cabinet & chassis**
- ★ **No setting-up required**
- ★ **All components except 5 mount directly on main pcb**

One of the most popular projects we have ever produced is the MOSFET amplifier described in the June 1981 issue of "Electronics and Music Maker". Its popularity is doubtless due to the virtues of the MOSFET transistors — as the article says: they are "virtually bomb-proof — like the best valve amps." For reliability, freedom from thermal runaway and extremely low harmonic distortion there's nothing to touch the MOSFET transistor for audio power output stages.

As well as offering these essential advantages this stereo amplifier has been carefully designed for absolute ease of construction; this in its turn adding to the reliability and repeatable quality for all constructors. All the components, bar five, mount directly on to the main pcb and only seven interconnecting wires are required and they are for the headphone socket and LED.

The inputs and outputs are on pcb mounting DIN sockets and provision has been made on the pcb for connecting a graphic equaliser, though you will need to drill the rear panel to make connection. Otherwise the kit contains everything you need including a punched chassis finished in matt black with legends printed on the front and rear panels. A wooden cabinet is also supplied which has to be glued together with a woodworker's PVA adhesive (e.g. Resin W) and this glue is not supplied in the kit.

No setting-up is required. If the building instructions are carefully followed then the amplifier will work correctly as soon as it is switched on. However, a preset is provided for each input (except auxiliary) which can be adjusted if desired, so that when switching between inputs, the volume control does not have to be altered to keep the output volume constant. In addition, a remote control unit for volume, bass, treble and balance will be published shortly — hopefully in the next issue.

Circuit Description

T1 is a toroidal transformer and was chosen as it has several advantages over conventional types. It is much more efficient as it runs cooler and has lower radiated magnetic fields keeping stray hum to a minimum. Its small size

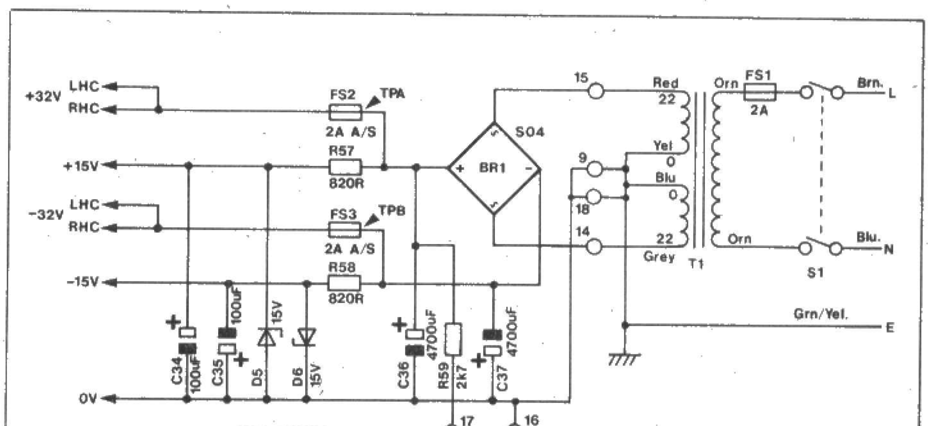


Figure 1. Circuit diagram of power supply.

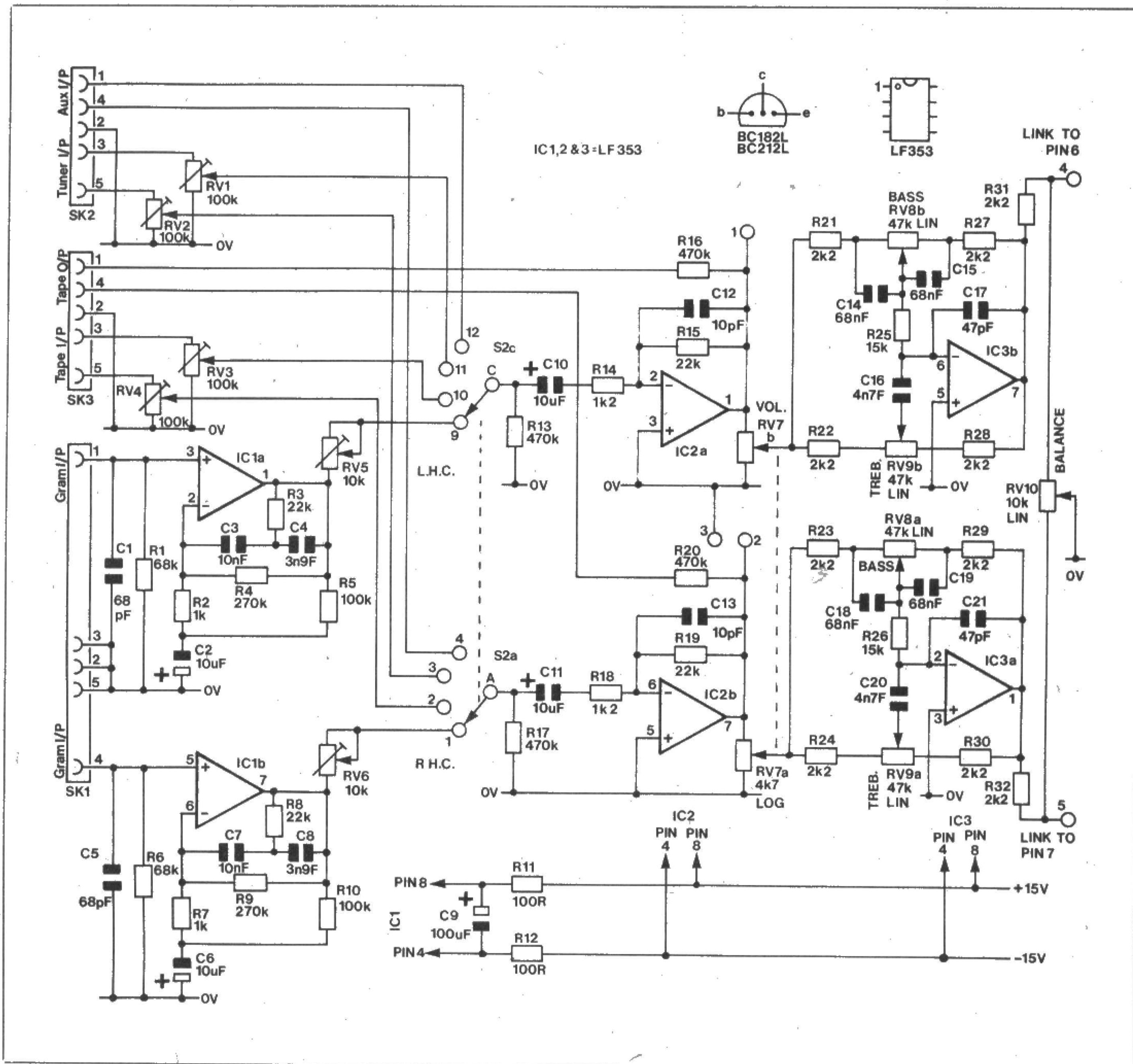


Figure 2. Circuit diagram of pre-amp and tone controls.

Specification of prototype

Input sensitivities for max. output (with preset adjusted for max. sensitivity).

Magnetic pick-up input: 2mV at 47kΩ
Tape input: 50mV at 100kΩ
Tuner input: 50mV at 100kΩ
Auxiliary input: 50mV at 470kΩ
Magnetic pick-up input overload threshold: 40mV
Tape output at rated input: 100mV into 100kΩ
Power output: > 26W per channel rms into 8Ω or 4Ω continuous at 1kHz both channels driven.
Total harmonic distortion: Better than 0.075% at 1kHz at > 25W output.
Frequency response: 20Hz to 40kHz ±1dB (from magnetic pick-up input ±1dB from RIAA)
Signal to noise: Better than 60dB on magnetic pick-up input. Better than 80dB on all other inputs
Channel separation: Better than 40dB
Bass control: ±14dB boost and cut at 100Hz
Treble control: ±8dB boost and cut at 10kHz
Balance control: -50dB to +1.5dB

also allows the cabinet to be low-profile and it has no open terminals making it intrinsically safer.

The transformer secondary is full-wave rectified by BR1 and smoothed by C36 and C37. The output via fuses FS2 and FS3 deliver ±32V to the MOSFET output stages only, whilst Zener diodes D5 and D6 and resistors R57 and R58 produce ±15V to drive the remainder of the circuitry in the amplifier. IC2 and IC3 are supplied directly from these rails, but IC1 has further decoupling provided by R11, R12 and C9.

IC1a and b is a dual bi-fet op-amp whose non-inverting inputs are suitably matched for use with magnetic cartridges. A degree of protection from stray rf is also provided. The feedback circuitry about each input produces a response to within ±1dB of the recommended RIAA curve. This is achieved by using frequency selective feedback to boost the lower and cut the upper frequencies. Presets RV5 and RV6 control the gain of the pick-up input and allow fine adjustment of channel balance or reduction of volume of high output magnetic cartridges.

RV1 and RV2 perform the same function for the tuner input and RV3 and RV4 for the tape input. If not required simply turn them to the end that gives maximum volume. The auxiliary input level is not presettable, but is selected along with the other inputs by S2. IC2 is a mixer stage supplying the tape output and has an almost perfectly flat response over the audio spectrum.

The volume control, RV7, supplies the selected input signal to IC3 which looks after the tone compensation. RV8 gives boost or cut of the bass frequencies while RV9 controls the gain of

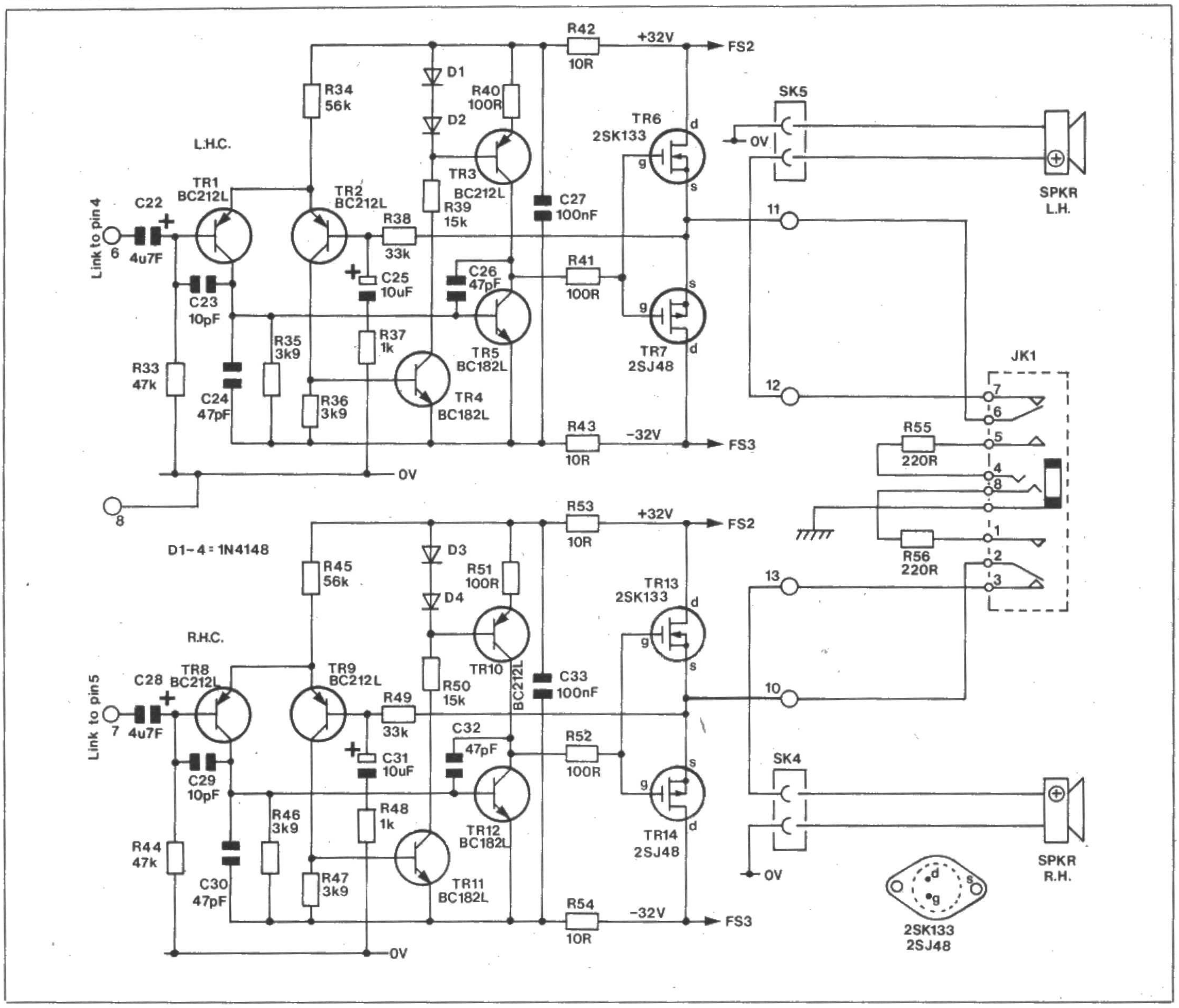


Figure 3. Circuit diagram of MOSFET power amp.

the treble frequencies. In their centre positions, this stage too has an almost perfectly flat response over the audio range. The balance control, RV10, simply shunts the audio signal to ground of the channel it is turned from.

Pins 4 and 5 are strapped to pins 6 and 7, but these straps can be removed if you wish to insert a graphic equaliser.

TR1 and 2 form a differential amplifier whose output is fed to TR5, a voltage amplifier/driver stage. TR3 is a constant current and impedance source which is controlled by TR4. The output of TR5 drives the power MOSFET's TR6 and TR7.

Power MOSFET's have a very low 'on' resistance and an extremely high 'off' resistance and display the characteristic channelling effect when driving into near short-circuits, since the forward resistance increases as the temperature of the device rises, unlike a bipolar transistor, where the opposite effect causes the destruction of the device. The effect allows circuit design to be simple and this in turn improves the distortion and noise figures.

Even further simplicity of design is achieved because the gates of MOSFET's having such a high impedance allows them to be connected and biased together without suffering from cross-over distortion. A small bias voltage is applied from a constant current set to around 20mA, though this is not critical and hence no setting-up is required.

The overall gain of the power amplifier is 33 as set by the ratio of R38 to R37. The power amp has a virtually perfectly flat response over the entire audio range with excellent stability and very fast switching or slew rate which gives an extremely wide power bandwidth, yet the damping factor is still very good.

The output of the power amp is fed to DIN sockets SK4 and SK5 which supply the external speakers, while JK1 disconnects this output and connects it via R55 and R56 to a stereo headphone when a plug is inserted.

The additional pins 1, 2 and 3 have been included so that a remote control unit for volume, bass, treble and balance may be added. Details of this easy-to-construct addition will be published shortly — hopefully in the next edition if space is available.

Construction

Main pcb

With reference to Figure 4 insert the 28 Veropins from the track side, then push them firmly home with the tip of a hot soldering iron and solder to the pcb. Fit the thirteen links using 24 swg tinned copper wire as shown in Figure 4. This Figure also shows how to fit and solder the two straps required between pins 4 and 6 and between pins 5 and 7 and again this should be done with the tinned copper wire and soldered.

Resistors R1 to R54 and R57 to R59 can now be fitted to the pcb. Bend the leads before insertion and push them down on to the pcb. If you cannot read the colour code directly, use the chart in the resistor section of our catalogue or the colour wheel (XL05F). Note that R3, 4, 8 and 9 must be 1% tolerance types and these are either marked 1% or they have a brown ring where the gold ring is found on 5% types.

Next insert the 1N4148 diodes, D1 to D4 and the two Zener diodes D5 and D6. These six diodes have a black band and must be placed on the pcb so that this band is at the same end as the white band printed on the pcb.

RV1 to RV6 are preset potentiometers. Carefully check the values stamped on the wiper: RV1 to RV4 are 100k and RV5 and RV6 are 10k. Fit these to the pcb. By now quite a jungle of leads will be forming beneath the pcb, so solder these in position and cut off all remaining ends close to the joint. It is advisable to check for shorts between tracks and soldered joints after each use of the soldering iron. Excess flux can be removed using cellulose paint thinner and a stiff paint brush, but use the thinners conservatively or a sticky deposit will be formed.

Next fit the ceramic plate capacitors. Their leads do not require bending and should fit straight in. Fit the tantalum bead capacitors C10, 11, 22 and 28 taking care that the '+' sign on the body of the capacitor lines up with the '+' sign printed on the pcb. The little box-shaped capacitors are the polycarbonates and should be fitted next, followed by the polystyrene capacitors whose leads should be pre-formed before fitting to the pcb.

This should also be done to the axial electrolytics C9, 34 and 35 which should be fitted next taking care that the '+' sign printed on the pcb is at the same end as the indentation that runs around the body of the capacitor. The vertically mounted electrolytics C2, 6, 25 and 31 are inserted straight into the pcb and again must be positioned so that the '+' signs are aligned.

Now solder all the components in position, trim the leads, clean and check the pcb as before then mount the three integrated circuits. The small dot

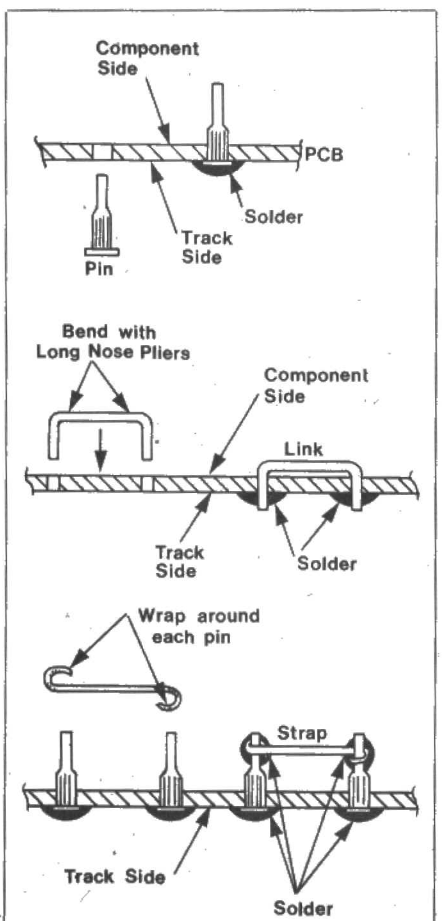
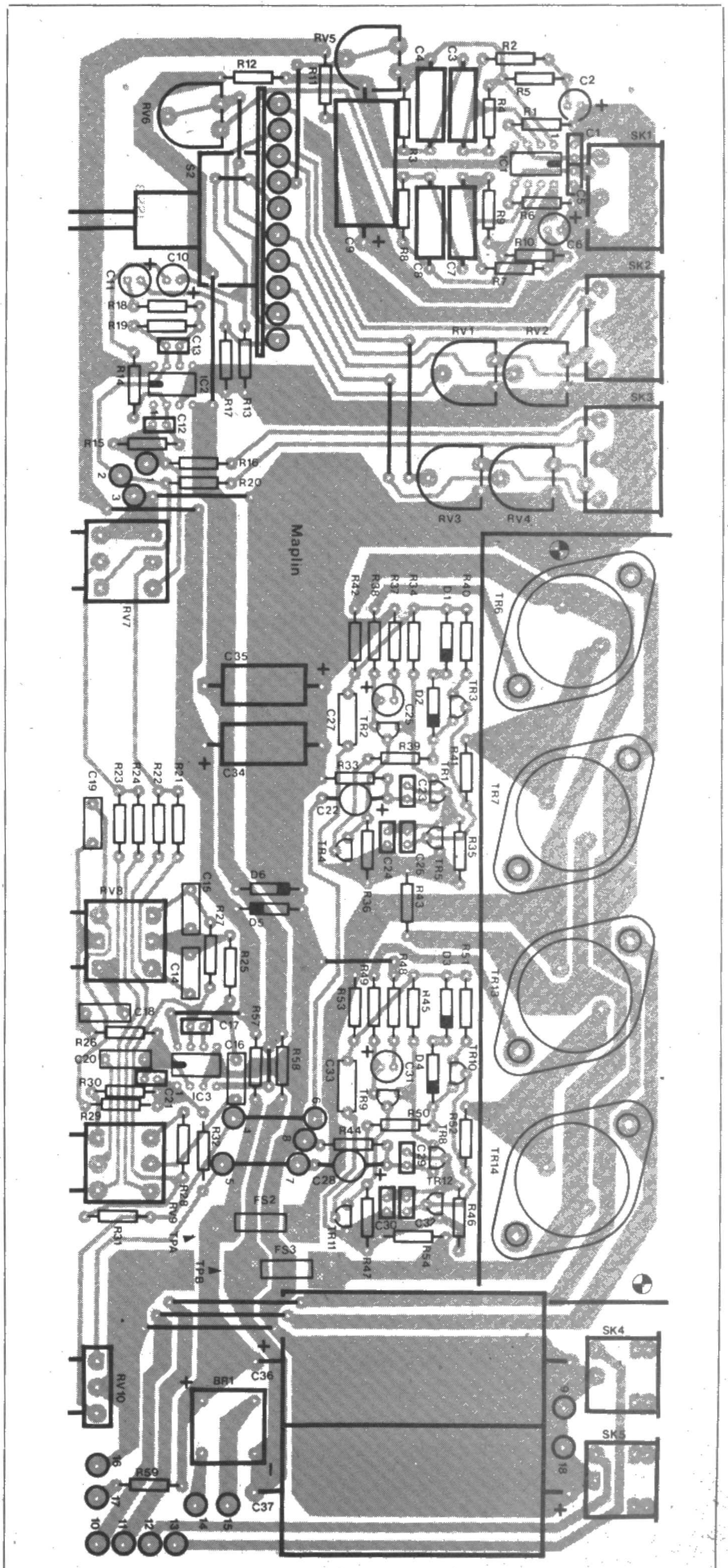


Figure 4. Insertion of pins and links in pcb.



Component overlay of main pcb shown less than full size.

on the top of the IC body indicates pin 1 and should be positioned so that it is at the same end as the 'D' shape formed on the pcb legend. Take care to ensure that all eight leads fit through the pcb on each IC.

Next, fit the bridge rectifier BR1. One edge of the plastic package has a '+' sign painted on it and as before this must be positioned to align with the '+' sign on the pcb. Push the plastic body right down onto the pcb.

Transistors TR1 to TR3 and TR8 to TR10 are type BC212L and their 'D' shaped package must line up with the pcb legend. The same applies to TR4, 5, 11 and 12 which are type BC182L. Push all these transistors down to about 0.5 to 1cm (¼in) from the pcb otherwise they can be easily bent or broken. Fit the two polyester capacitors C27 and C33. These are usually colour coded and from the top the colours are brown, black, yellow, black or white, red or yellow. Now solder all these components as before.

Place the FET mounting bracket over the pcb on the component side and bolt in position with two nuts, washers and 6BA ¼in bolts inserted from the track side. Ensure that the top of the bracket is perfectly smooth and clean. Carefully adjust the position of the bracket so that 16 holes (4 per FET) in the pcb are exactly centralised under the holes in the bracket, and then tighten the bolts. This operation is very important as misalignment will result in a short circuit between the FET and the bracket (0V). One bolt passes through a large area of track and to ensure that there is a good connection between this track (0V) and the bracket, solder the bolt head to the track.

Smear a thin layer of Thermpath over both sides of a mica insulator and place it on one of the power FET's then repeat with the other three. Place each FET with its insulator over the mounting bracket noting that the two leads on the 2SK133's are towards the rear of the pcb (the bracket itself is on the rear edge) and on the 2SJ48's they mount towards the front.

With reference to Figure 5 insert two 6BA ½in bolts from the track side up through each MOSFET and tighten up with 6BA washers and nuts. Solder the FET leads to the pcb and then solder all eight bolt heads to the pcb.

The four small fuseholder clips may now be fitted. The easiest way to do this is to clip a fuse between each pair and then place and solder the whole assembly to the pcb. Remove the fuses when this is completed.

Fit the three 5-pin DIN sockets, SK1 to SK3, ensuring that all seven pins (2 are securing pins) go through the pcb and none are left bent underneath. Sockets SK4 and SK5 should be fitted in the same way. The last two axial electrolytic capacitors C36 and C37 can now be fitted. They mount with polarities in opposite directions so take care to ensure that the indentation around the body is at the same end as

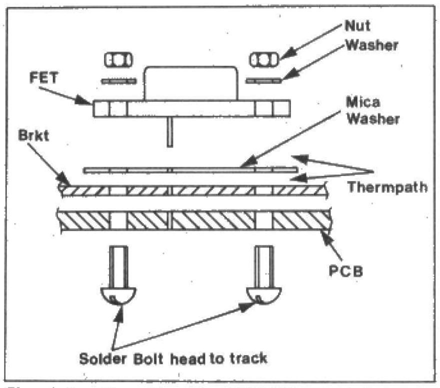


Figure 5. Mounting the MOSFET transistors.

the '+' sign on the pcb. Solder these last seven items to the pcb.

The four-way rotary switch S2 has to be prepared before it can be mounted. Firstly, straighten all fifteen tags on the back of the switch then cut off the tags marked B, 5, 6, 7 and 8 close to the plastic moulding. Secondly, cut off the loops on the ends of the remaining ten tags leaving as much straight pin as possible. Refer to Figure 6. The switch can now be fitted to the small pcb ensuring that all ten pins have come through and solder them in position.

On the main pcb there are ten Veropins situated near the front left side of the board. Lightly tin these pins with a soldering iron (i.e. cover each pin with a *thin* layer of solder). With reference to Figure 7, place S2 facing towards the front of the main pcb and offer the switch pcb up to the ten pins so that they align with the ten tracks on that pcb. Hold the board as upright as you can and solder one pin. Resolder if the

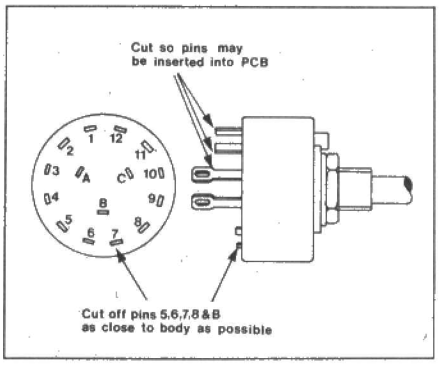


Figure 6. Preparing switch S2.

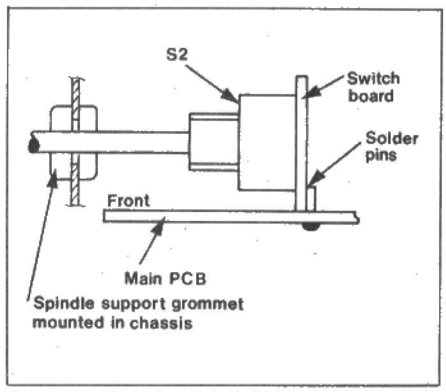


Figure 7. Mounting switch S2.

board is not perfectly upright, then when satisfied, solder the remaining nine pins.

Finally, mount the four rotary potentiometers on the pcb checking the resistance values against the RV numbers to ensure correct placement, before soldering. The pcb is now complete and should be cleaned up. Re-check all components for correct values and correct orientation of polarised components. Check for dry joints and short circuits and carefully resolder any suspect joints.

If you possess a multimeter, check for short circuits between the pins and case of the MOSFET transistors and the mounting bracket. Switch to ohms and with one lead on the bracket check each lead and case in turn. If there are any short circuits then you will have to strip down the mounting bracket to find out why, but careful construction should have prevented this.

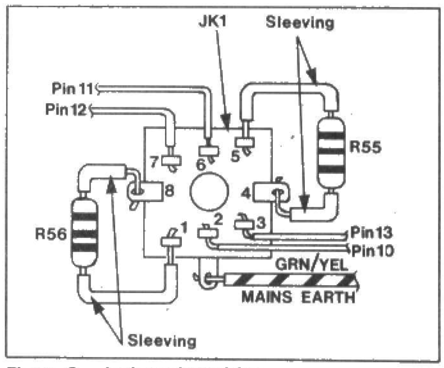
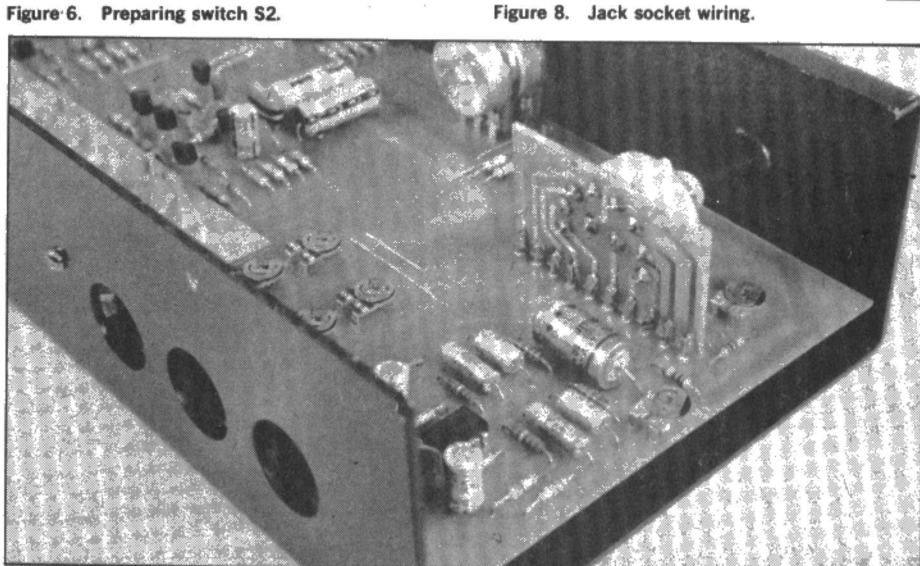


Figure 8. Jack socket wiring.



Mounting of switch pcb.

Assembly

Cut the four potentiometer spindles so that they are about 13mm (½in) long. Remove the nuts and washers from RV8 and RV9 but leave them on RV7 and RV10 and tighten up these two. Fit a grommet into the selector switch hole in the front panel, then slide the pcb into the chassis by guiding the control spindles in first, then lowering into position.

Bolt the mounting bracket to the back of the chassis using three 6BA ¼in bolts and nuts, two washers and a solder tag with the bolts inserted from the outside. The tag washer fits on the bolt nearest to the two 2-pin speaker sockets. The two remaining pot mounting washers and nuts fit onto RV7 and RV10 and tighten up on to the chassis. Make sure that all five DIN sockets line up with the holes in the chassis and readjust to suit.

With reference to Figure 8 slide a piece of sleeving over each wire on R55 and R56 then solder them between tags 4 and 5 and tags 1 and 8 of the jack socket. Cut four pieces of wire each 125mm long, and strip and tin a short length at each end of each piece. Solder these four wires to tags 2, 3, 6 and 7 on the jack socket. Fix the jack socket to the front panel then connect the four wires to the pcb as follows:

JK1 tag	to	pcb pin
2		10
3		13
6		11
7		12

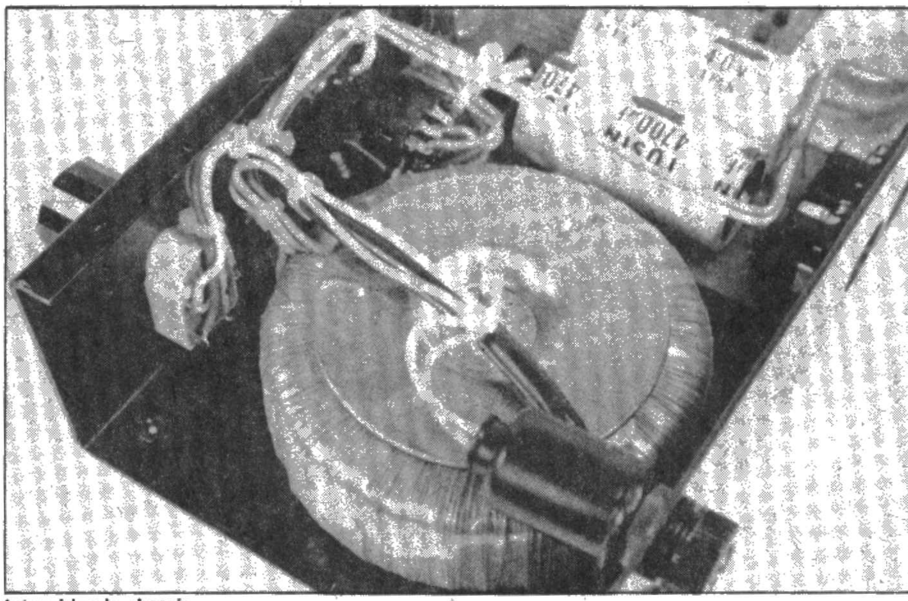
Keep all wiring as short as possible and neatly laid out. Thin wire or cable ties could be used to hold groups of wires together, but there is so little wiring in this project that it is not really necessary and no problems should be encountered. Figure 9 shows the complete wiring arrangements.

Cut two pieces of wire each 150mm long and strip and tin a short length at each end of each piece. Connect one wire to each lead on LED1. A tiny '+' and '-' sign is stamped into the plastic beside each lead, but for those who cannot see them the thicker lead is the negative and the thinner lead is the positive. See Figure 10. Fit the LED in the chassis next to the headphone socket and connect the two wires to the pcb as follows:

LED1	to	pcb pin
+ (thin)		17
- (thick)		16

Now mount the toroidal transformer T1 as shown in Figure 11. Insert the bolt (supplied with the transformer) from under the chassis base through the hole in the indent. Place one of the two rubber washers over the bolt, then the transformer with the wires uppermost. Put the remaining rubber washer on top followed by the clamping plate. Tighten in position with the nut and washer supplied with the transformer.

Carefully scrape the enamel coating off a short length of the end of each of the transformer's six wires. This can be



Interwiring in chassis.

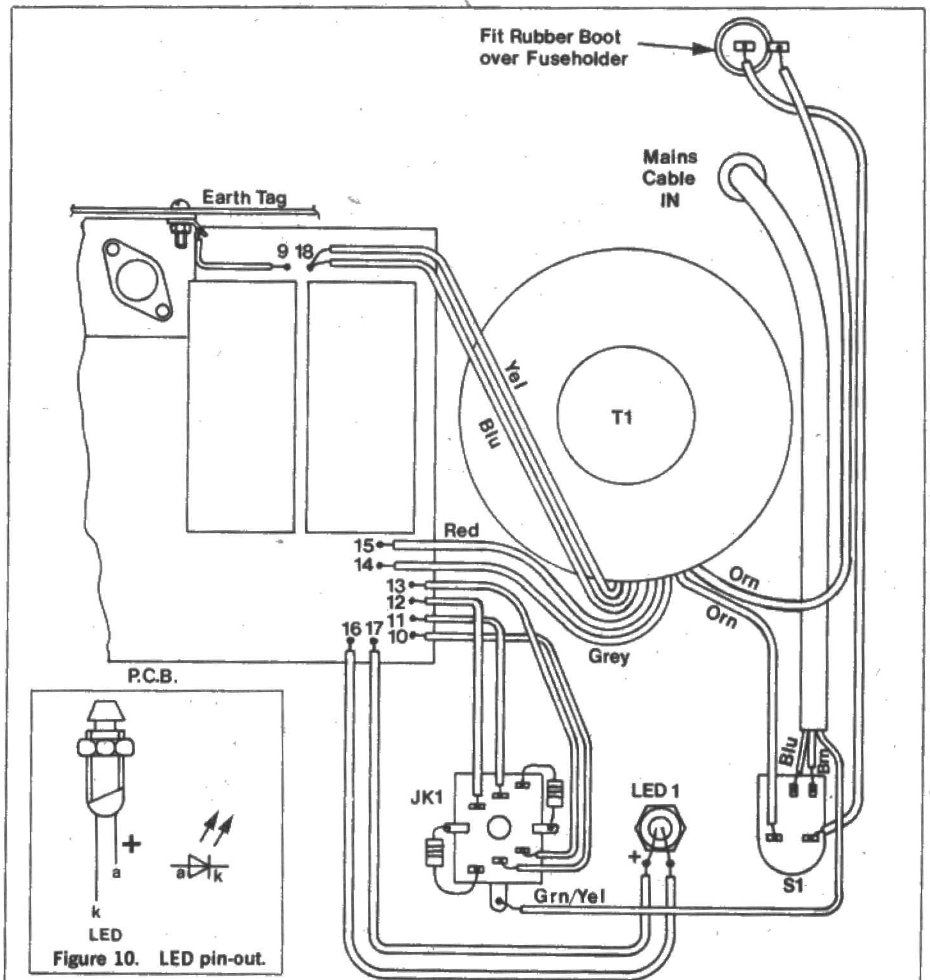
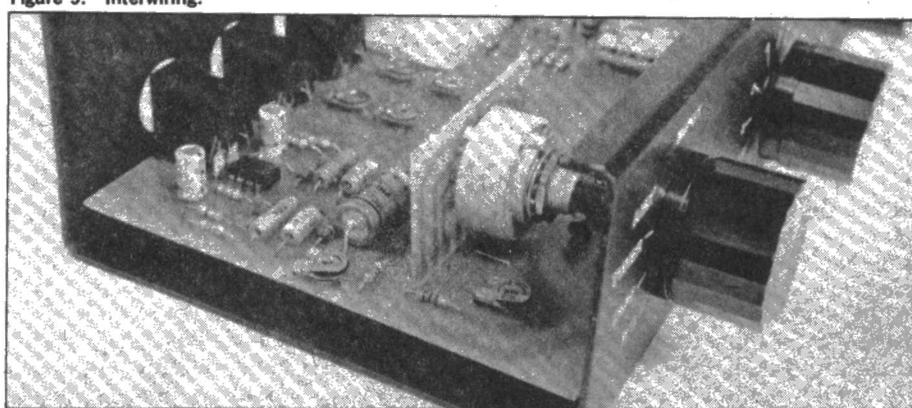
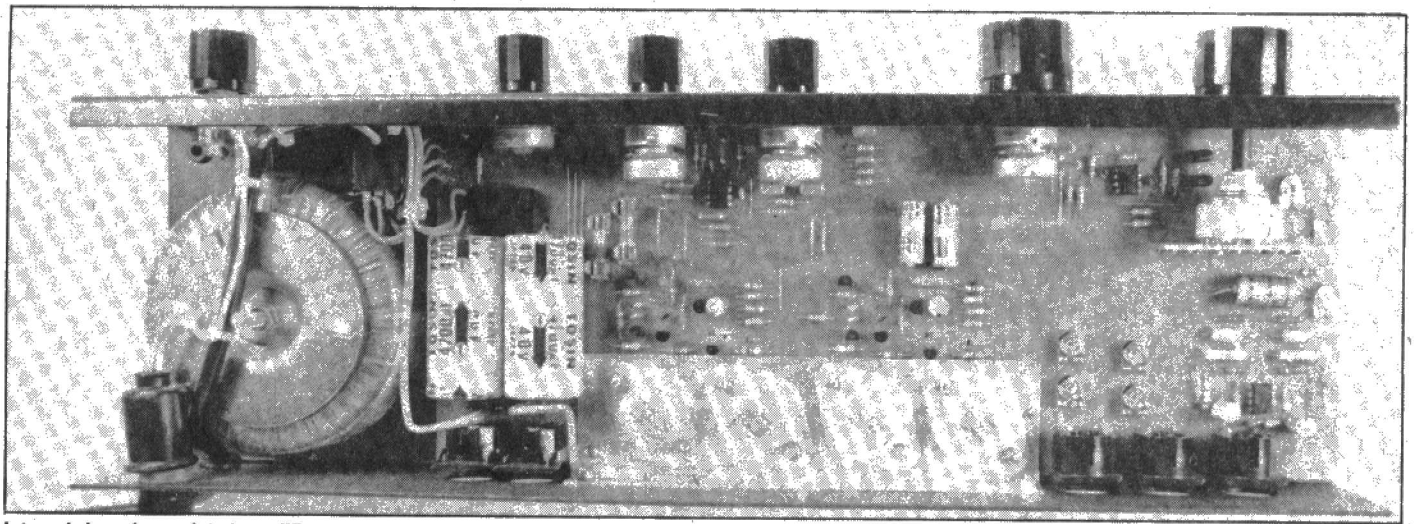


Figure 10. LED pin-out.

Figure 9. Interwiring.



Switch pcb front view.



Internal view of completed amplifier.

done with a sharp knife or a piece of fine emery cloth or wet and dry. Twist together the blue and yellow wires and connect both to pin 18 on the pcb. Connect a short length of wire between pin 9 and the earth tag as shown in Figure 9. Form the red and grey wires around to the bridge rectifier and solder on to pins 14 and 15 on the pcb. It makes no difference which wire goes to which pin.

Fix the chassis fuseholder to the rear panel above T1 and fit a rubber grommet in the hole beneath it. Fix the rotary mains switch S1 to the front panel taking care that the small spigot fits into the matching hole. Cut the spindle to the same length as the other spindles. Also trim the spindle on S2 to this length.

Connect one of the orange wires from T1 (it doesn't matter which one) to the side tag on the fuseholder FS1, after sliding the rubber boot over the wire first. Cut a piece of wire about 150mm (6in) long, strip and tin each end then pass it through the rubber boot and connect it to the rear tag on FS1. Solder both wires, then push the rubber boot forward so that it completely covers the body of the fuseholder.

Connect the other end of this wire to one of the top two terminals on switch S1. Then connect the other orange wire from T1 to the other top terminal on S1. Strip 80mm (3in) of the outer covering of the piece of mains lead and strip and tin a short length of each of the three internal wires. Put the mains lead through the grommet in the rear panel and terminate the blue wire to the tag on S1 immediately below the orange wire from T1 and terminate the brown wire to the tag on S1 immediately below the piece of wire from FS1.

The mains earth (green and yellow wire) should be connected to the earthing tag on the top of JK1. Ensure that all the connections you have made are properly soldered. Check carefully for dry joints and short circuits. Insert the 2A antisurge fuse into FS1 and ensure that the other two fuses are NOT inserted into their clips on the main pcb. Fit the control knobs on to the spindles as shown in the photographs.

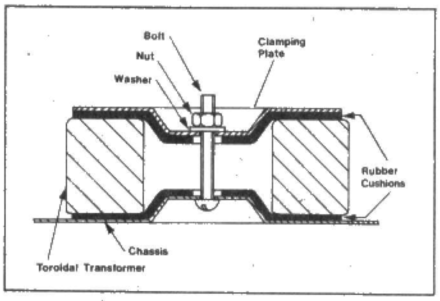


Figure 11. Mounting the toroidal transformer.

Finally check that the last section of wiring is identical to all the diagrams. The amplifier is now ready for testing.

Testing

Fit the 13A mains plug to the mains cable. The rear of S1 could be covered with insulating tape if desired and it would then be quite safe to work in the amplifier with the mains connected without risk of a shock. On no account, however, should children or untrained persons be allowed near the amplifier in this condition. Little fingers could easily unpeel your carefully applied insulating tape with potentially lethal results.

Do not connect any loudspeakers or inputs at this stage and fuses FS2 and 3 must not be fitted. Set all the front panel controls fully anticlockwise. Adjust presets RV5 and RV6 to half-way and set RV1, 2, 3 and 4 fully clockwise. Give the project a final visual inspection then connect the mains plug to the mains and switch the amplifier on by turning S1 clockwise.

LED1 should light up. If it does not switch off, remove the mains and check fuse FS1. If it is still intact, try reversing the wires on pins 16 and 17 on the pcb. Switch on again. If all is well switch a multimeter to 50V DC or 100V DC or thereabouts, connect the negative lead to the metal chassis or the tag on the top of JK1 and the positive lead to pin TPA on the pcb. The meter should read around +32V (±5V). Now put the meter's positive lead to the chassis and connect the negative lead to pin TPB on the pcb. Again the meter should read the same voltage as before i.e. -32V (±5V).

Switch off. If all is well the other two 2A fuses can now be fitted into the fuse clips on the pcb. If desired and you have sufficient knowledge, two further checks can be made. The +15V rails can be checked on D5 and D6 and you should obtain a reading of above 100mV DC between the cases of the four power MOSFET's and the chassis.

The treble, bass and balance controls can now be set centrally. Speakers may now be connected and inputs as required. The input connections are as follows:—

SK1 Magnetic pick-up input (5-pin DIN 180°)
Pin 1 Left channel input
Pin 4 Right channel input
Pins 2, 3, 5 Common (0V)

SK2 Tuner/Aux input (5-pin DIN 180°)
Pin 1 Auxiliary left channel input
Pin 4 Auxiliary right channel input
Pin 3 Tuner left channel input
Pin 5 Tuner right channel input
Pin 2 Common (0V)

SK3 Tape input/output (5-pin DIN 180°)
Pin 1 Tape left channel output
Pin 4 Tape right channel output
Pin 3 Tape left channel input
Pin 5 Tape right channel input
Pin 2 Common (0V)

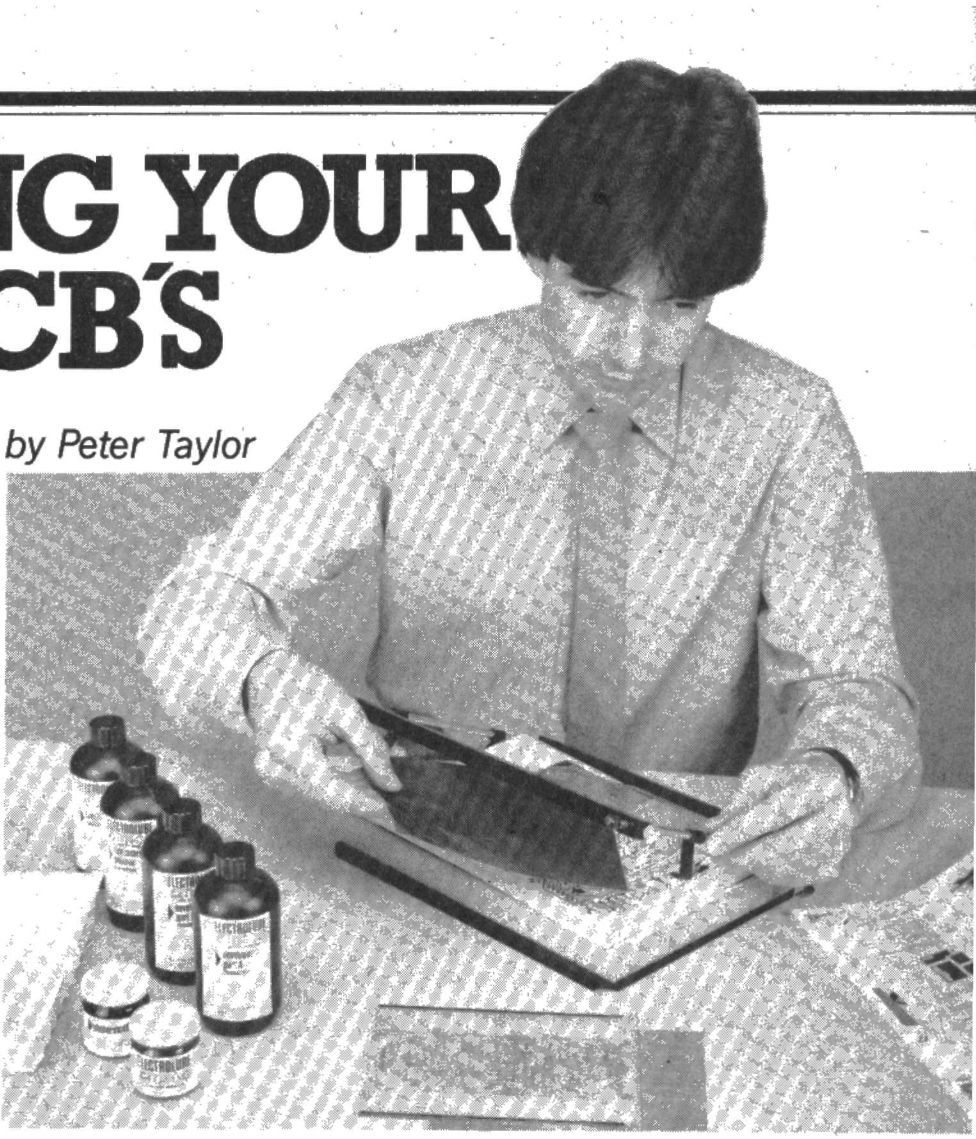
If when any particular input is selected there is an obtrusive hum, try disconnecting the earth from the plug at one end of the interconnecting lead. Check out the remaining functions of the amplifier and adjust the six presets RV1 to 6 to suit your equipment if desired.

Carefully fold the wooden cabinet glueing the corners together with a PVA adhesive such as Evostik's "Resin W". Slide the chassis into the wooden sleeve when the glue is properly set, so that the four holes in the bottom line up with the four holes in the base of the chassis. Then bolt on the four rubber feet using the four 4BA ¾in bolts supplied in the kit. If you have bought the parts separately, you will need to cut the excess length off the 4BA 1in bolts. The amplifier is now complete and its reliable, superb quality should give many years of listening pleasure.

Continued on page 55.

MAKING YOUR OWN PCB'S

by Peter Taylor



Printed circuit board construction is becoming increasingly necessary for many electronics projects, owing to circuit complexity and layout considerations. Whilst most magazines publish a printed circuit layout for some of their construction projects, this is of limited use to most constructors as they have no means of copying it. Of course, it is possible to trace the layout, but this is both untidy and time consuming, quite apart from being difficult and prone to errors. This article describes various ways in which the constructor, who has no previous photographic skill, can reproduce these layouts, and then make his own printed circuit boards (pcb's).

Large Scale PCB Production

Pcb's are produced professionally by making the artwork 2 x or 4 x size, and then reducing this to same size, in a large process camera. This increases the accuracy of the final copy by reducing any errors in the layout by a factor equal to the camera reduction. The resulting photographic negative (or positive) is used as a 'phototool' to produce a facsimile image of the layout on a copper-clad printed circuit board that has been coated with a light sensitive resist. When the board is etched, copper is removed from all those parts not protected by resist. This leaves a reproduction in copper of the circuit layout. Most published layouts are same size positives (i.e. the copper tracks are printed in black). These are quite easy to copy photographically without the use of a camera, or other expensive equipment. The principal used is that of reflex copying, and is illustrated in Figure 1.

Light passes through the photographic film or paper; it is reflected by the white areas and absorbed by the black areas. The photographic material therefore receives more exposure from the white parts of the copy than from the black. Processing the photographic material results in a same size copy of the artwork.

Two types of suitable photographic material are available; one is negative emulsion on paper and the other is a positive emulsion on film. The negative emulsion reproduces the artwork as printed, but laterally reversed. As all the photoresists available to the amateur at the moment are positive working (i.e. require a film positive of the artwork) it is much more economical in both time and materials to use the direct positive method.

The CM100 — Circuit Maker

In order to produce a high quality printed circuit board, the film positive must have dense black lines and a clear background. This quality is achieved using a high contrast film processed in a special developer. Unfortunately until now, these products have only been available to the professional large scale user. However, Electrolube Limited are now introducing a printed circuit kit (CM100 — Circuit Maker) which makes them available in quantities suited to the needs of the small scale user.

The film used in this kit has the advantage that no darkroom is needed; it can be handled quite safely in normal room lighting.

The steps necessary to make a film copy from a published artwork are simple. First of all a piece of film is cut slightly larger than the circuit being copied. This is then laid over the circuit layout with the emulsion of the film (i.e. the blue/grey side) in contact with the drawing. The two are sandwiched between a piece of clear glass, and a backing plate covered by foam rubber. The whole of this is then put under pressure, so that the film and the printing are held in even, close contact. Electrolube supply, with the CM100 — Circuit Maker, a frame that has been specially designed for this purpose.

The frame is placed two feet away from a high intensity photoflood lamp, and a series of stepped exposures is achieved by progressively covering the film with a piece of card. These exposures should range between 2 and 5 mins. in 20 second intervals. The film is developed for 2½ mins. in special developer at 20°C, and then placed in a bath of photographic fixer for a minute or two. The processed film will show a series of steps going from very dark to quite light. It is helpful to remember when assessing the step wedge that the longer exposures produce the least density. One of these steps will have a nearly clear background with dense, sharp black lines. The exposure given to this step should be noted, and used to produce a complete copy of the original.

When the final copy has been made, you may find that the background is not completely clear; it may be slightly darker at the corners (due to 'fall-of' of light used to expose the film). This background may be cleaned by taking the film straight from the fixer bath and wiping over the emulsion side with a swab of cotton wool dipped in Electrolube film clearing solution. The film is then refixed for a minute and washed in running water before being hung up to dry.

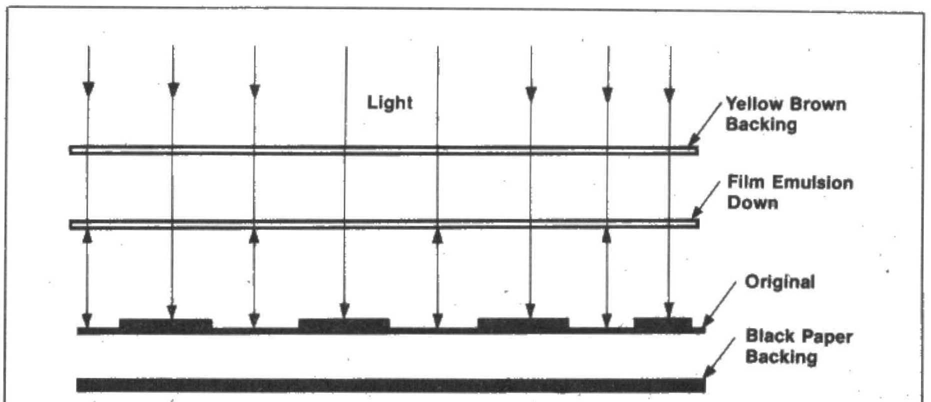


Figure 1. Principal of reflex copying.

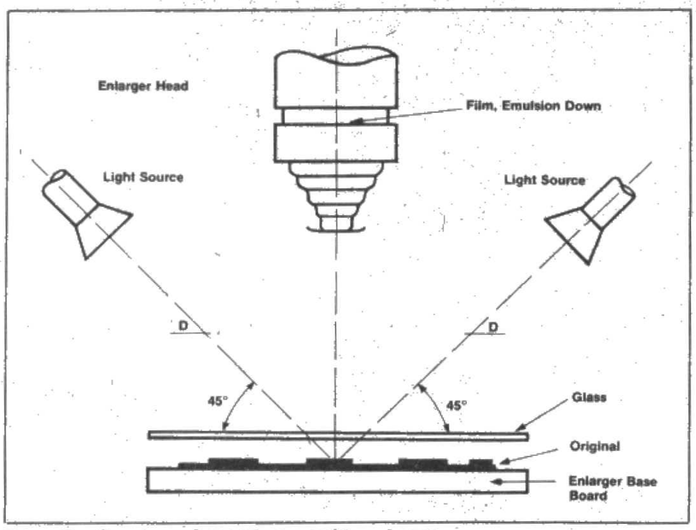


Figure 2. Copying using a photographic enlarger.

The comprehensive Electrolube CM100 kit.

Alternative Method Using a Photographic Enlarger

Another method that can be used by constructors who have a photographic enlarger and a darkroom is to use the enlarger 'in reverse' as a camera. The enlarger will have been set up so that the lens and negative holder are parallel to the baseboard and is therefore ideal for producing accurate copies of the circuit layouts.

For this method, the circuit to be copied is placed under glass in the centre of the baseboard. A negative is then placed in the negative carrier, and the enlarger adjusted so that the image of this negative covers the artwork being copied and is sharply in focus on the page. The controls on the enlarger should then be locked in position, and the enlarger light turned off.

The artwork is illuminated by two lamps equally spaced from the centre of the copy and at 45° to it, as shown in Figure 2. The negative that was used for focussing should now be replaced by a piece of negative working photographic line or lith film, with its emulsion towards the enlarger lens, and a black cloth draped over the enlarger. The film is exposed by switching the two lamps that illuminate the baseboard. Correct exposure time is found by trial and error initially. Providing the lamps are always kept at the same distance, and the lens aperture is not changed, this time should remain the same for future use.

The negative will normally be smaller in size than the original. It is therefore necessary to enlarge this to the right scale by using the enlarger in the conventional mode. The same type of film that was used for the negative is suitable for making this final film positive.

Normally layouts are published as seen from the copper side. In order to make the film positive the right way round, the negative should be placed in the enlarger with its emulsion side towards the light (i.e. the opposite way round to normal).

Producing The Printed Circuit Board

First we will briefly consider some ways of producing pcb's without the use of photography.

The most well known of these involves tracing the track pattern directly on to the copper laminate using carbon paper, and then filling in the areas that are to remain as copper with an etch resist pen, or painting with an etch-resistant material such as nail varnish.

Although these both work well as etch resists, it is extremely difficult to produce clean accurate shapes (such as integrated circuit pads), or the fine, closely-spaced lines that are necessary in many circuits. Moreover, the pattern has to be redrawn for each board that is made; consequently modifications, etc become extremely tedious.

Some of the disadvantages discussed above can be overcome by using certain dry transfer symbols, but, of course, it is still necessary to redraw the artwork for each board or modification that is made.

Whichever of the above techniques is used, it is practically impossible to make a double-sided board, and very difficult to achieve any degree of accuracy.

Photographic methods overcome these problems easily and efficiently, as described below.

To begin with the copper laminate is coated with a light sensitive photoresist; this is then exposed through the photographic film copy ('phototool') to ultra violet (i.e. a UV lamp or daylight). Areas that are exposed sufficiently are removed during subsequent development of the resist, leaving an image of the circuit layout which can then be etched.

The copper laminate is first cleaned by rubbing with a fine abrasive pad (as used for washing up). It is best to wet the surface of the board thoroughly with warm water to which a little washing up liquid has been added. When the copper surface appears shiny, the board should be rinsed in running water. If the cleaning has been successful, the water will form an even film over the board surface. If it forms dry patches, cleaning should be repeated.

Wipe away surface moisture with a lint-free cloth and leave the board to dry. Now apply photoresist by aerosol, or by wiping on with a special applicator (as in the Electrolube CM100 — Circuit Maker). The board should be kept horizontal until the resist has dried, otherwise run marks will occur. After coating, put in a dark cupboard until dry. The board should be ready for exposure to the film master in about 45-60 mins. This is carried out in the same frame used to produce the film master. The film is laid on to the photoresist-covered board, and the two are clamped together. Exposure can be to daylight or to a UV lamp. Using the resist supplied with the Electrolube CM100 — Circuit Maker, exposures in the region of 10-30 mins. to daylight can be expected, depending on the strength of the light.

After exposure, the resist is developed in a weak solution of caustic soda. All the parts exposed through the clear areas of the film are removed, leaving a positive copy of the circuit in resist.

After a brief rinse the board can be etched straight away. Various substances can be used, the most common being ferric chloride. This is normally made into a solution containing 1lb of ferric chloride in 2 pints of water. Great care should be exercised when dissolving the ferric chloride — a lot of heat is generated and the reaction is quite violent. **On no account should water be added to ferric chloride — ALWAYS add the ferric chloride to the water.** If any solution should be splashed accidentally into the eyes or mouth, wash with plenty of water, and then seek medical attention.

The Electrolube CM100 — Circuit Maker makes use of a much safer process which is a buffered etchant supplied in a heavy duty polythene container. In this case water is added to the crystals in the bag and, when they are dissolved, etching can begin. The copper board is dropped into the bag, and the bag sealed with a special clip. It is then laid flat on the bench, and pressure is gently exerted with the palms of the hands alternately at each end. This agitates the solution sufficiently; the board should be etched completely in 10-15 mins.

The board is now rinsed thoroughly in running water. The residual photo-resist is stripped by immersing the board in about 2% caustic soda. After a further wash, surplus surface moisture is wiped away, and the board put to dry.

It is necessary to protect the copper surface from tarnishing by applying a flux lacquer to the copper side of the board. This allows the board to be stored; it also gives excellent solderability. The flux lacquer in the Electrolube CM100 — Circuit Maker is applied in a similar way to the photoresist.

Making professional-quality printed circuits at home is easy, providing it is tackled in a methodical way, and attention is paid to cleanliness throughout. The Electrolube CM100 — Circuit Maker, which is on special offer in this issue, facilitates this; it supplies everything necessary for the small scale user to make his own single or double-sided boards from his own or published artwork. Great care has been taken to make the kit complete. A feature that will prove invaluable to many constructors is that the specially designed frame can be used as an exposure frame for the photographic parts of the process, as well as a component assembly frame. The foam backing is of a special heat-resistant type which allows it to be used to clamp the components; this prevents the components dropping out of the board when it is turned over for lead cropping and soldering. ■

BASICALLY BASIC

Graham Hall, B.Sc.

BASIC Strings

A BASIC string is a sequence of one or more letters or symbols in any combination, enclosed within quotation marks. It is treated as a single collection of alphanumeric data which can be manipulated by means of string functions and assigned to string variables. The use of string variables, string assignment and string arrays has been described in previous parts of 'BASICALLY BASIC'. To understand how the computer represents alphanumeric data and can perform operations with strings, we need to look at the ASCII code (American Standard Code for Information Interchange).

ASCII Code

The ASCII code is a standard developed by the computer industry in which each symbol used in BASIC is assigned a unique binary digit pattern (bit pattern). When a symbol is typed on the keyboard, the terminal converts it to its binary code. For example, if you type the letter A on the keyboard, the terminal converts it to Ø1ØØØØØ1, which the computer recognises as A. Table 1 lists the set of ASCII character codes. The binary numbers have been converted to decimal numbers to make the assignments easier to understand.

The ASCII code is used to determine alphabetic precedence when alphanumeric data is compared with relational operators. This is described in the next section.

String Operators

A relational operator is a symbol used to compare the value of one variable or expression to another variable or expression within a BASIC program. The use of relational operators to determine numeric relationships has been described previously. Relational operators can also be used to compare alphanumeric data. The comparison is made in terms of the ASCII value of characters to establish alphabetical sequence. Consider the following program:

```
1Ø LET A$ = "BAS"
2Ø LET B$ = "SIC"
3Ø IF A$ < B$ THEN PRINT A$:GOTO 5Ø
4Ø PRINT B$
5Ø END
```

Line 1Ø assigns the string BAS to the string variable called A$.
Line 2Ø assigns the string SIC to the string variable called B$.
Line 3Ø is a relational string expression. It compares string A$ with B$ to determine if A$ occurs first in alphabetic sequence. The comparison is made character by character using the ASCII character code. In this case the first letter of the string A$ is 'B' which precedes 'S', the first letter of the string B$, in the ASCII table. Therefore string A$ precedes B$ in alphabetic sequence so the condition is true and the string A$ is printed on the terminal. If the first two characters are the same the comparison proceeds to the second two characters, until a difference is found. For example, if A$ was assigned to the string BAY and B$ was assigned to the string BAT, the first character in each string match. The next two characters also match. Finally the last character of the string A$ is compared with the last character of the string B$. The ASCII code of Y (89) is greater than the ASCII code of T (84), hence the result of the comparison is false and line 4Ø prints the string B$ on the terminal.

Table 2 lists the string relational operators available in BASIC and their meaning.

Note: it is not permissible to compare a numeric or integer expression to a string expression using a relational operator. If this is attempted an error message will be output by the computer.

String Functions

BASIC provides a set of string functions (similar to the math and print functions described last month) to enable certain operations to be performed on strings. The following descriptions are intended to be general since the functions may perform differently for different computer systems. You should refer to your systems Language Reference Manual for a complete list of functions available in your version of BASIC. The string function names ending with a dollar sign ($) return a string value whereas function names not ending with a dollar sign return a numeric value.

ASCII Function

The ASCII function returns a numeric value that is the equivalent ASCII code for the first character in the string given as the argument to the function. The general format of the ASCII function is: ASC (string), where string is either a string constant or a string variable. For example, the command PRINT ASC ("P") will output 80, the decimal ASCII value of the character P, on the terminal. The following program uses the ASC

function with a string variable as an argument:

```
10 A$ = "BASICALLY"
20 PRINT ASC (A$)
30 END
```

When the program is run the ASCII function returns the decimal ASCII value of the first character in the string assigned to the string variable A$, hence the decimal 66 will be output to the terminal.

CHR$ Function

The CHR$ (Character) function is the inverse of the ASCII function. It returns a single character string having an ASCII value of the numeric value specified as the argument to the function. The range of the ASCII codes is Ø to 127. If the value specified to the CHR$ function is outside this range it is treated as modulo 127. This means that 128 is treated as Ø, 129 as 1 and so on. A non-integer argument to the CHR$ function will be truncated and the character returned will be that represented by the truncated number.

The following program demonstrates the use of the CHR$ function with different arguments.

```
10 PRINT CHR$ (70)
20 PRINT CHR$ (198)
30 PRINT CHR$ (10)
40 PRINT CHR$ (60.1)
50 END
RUN
F
F

<
```

The output from the program is as shown.
Line 1Ø prints the character represented by the ASCII code 7Ø (an upper-case F).
Line 2Ø specifies an argument of 198. This is treated as modulo 127 (198 - 128 = 7Ø) which is the ASCII code for an upper-case F.
Line 3Ø outputs a line feed character on the terminal causing a blank line of output. The decimal number specified as an argument to the CHR$ function on line 4Ø is truncated to an integer. The truncated number (6Ø) represents the character<. (Characters may be different with your micro.)

The remaining BASIC string functions will be described in the next 'BASICALLY BASIC'. ■

Operator	Example	Meaning
=	X$=Y$	Strings X$ and Y$ are equivalent in characters after removing trailing blanks and nulls.
<	X$<Y$	String X$ occurs before string Y$ in alphabetical sequence.
< =or=<	X$< =Y$	String X$ is equivalent to or occurs before Y$ in alphabetical sequence.
>	X$>Y$	String X$ occurs after string Y$ in alphabetical sequence.
> =or=>	X$>=Y$	String X$ is equivalent to or occurs after Y$ in alphabetical sequence.
<>	X$<>Y$	String X$ is not equal to string Y$
==	X$==Y$	Strings X$ and Y$ are identical in characters and length.

Table 2. String relational operators.

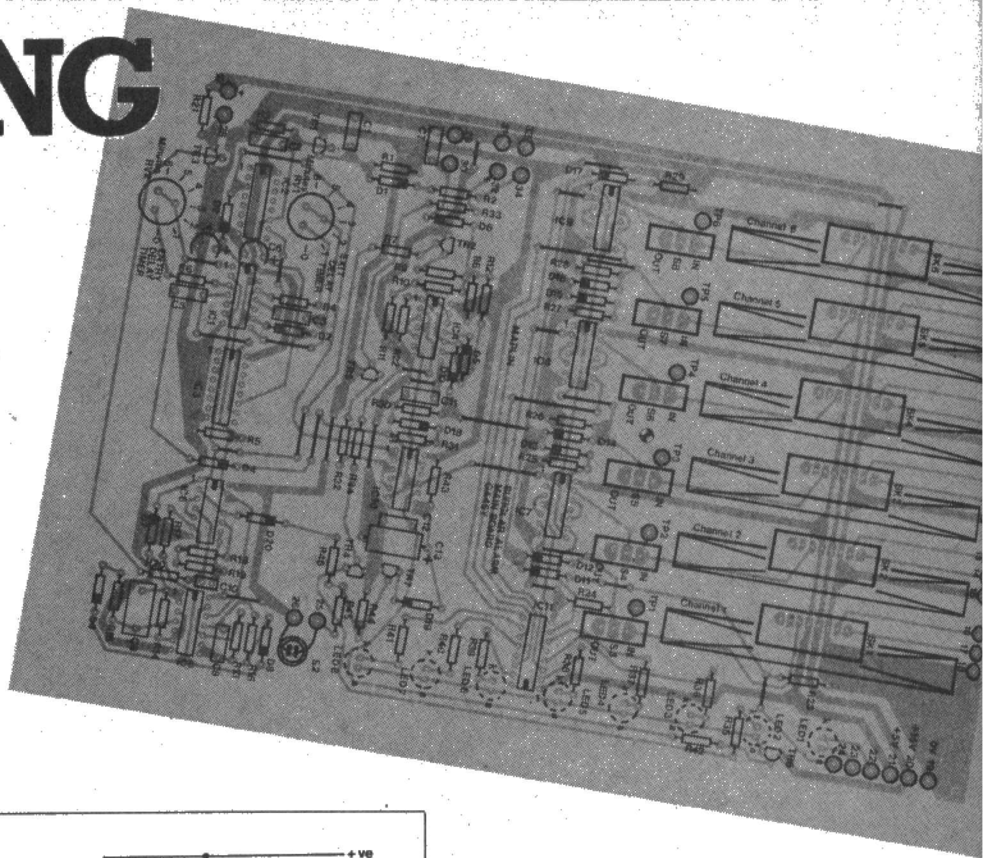
▼ **Table 1. ASCII character code.**

Decimal	Character	Meaning	Decimal	Character	Decimal	Character
000	NUL	Null	043	+	086	V
001	SO11	Start of heading	044	,	087	W
002	STX	Start of text	045	—	088	X
003	ETX	End of text	046	.	089	Y
004	EOT	End of transmission	047	/	090	Z
005	ENQ	Enquiry	048	0	091	[
006	ACK	Acknowledge	049	1	092	\
007	BEL	Bell	050	2	093	]
008	BS	Backspace	051	3	094	↑
009	HT	Horizontal tab	052	4	095	←
010	LF	Line feed	053	5	096	`
011	VT	Vertical tab	054	6	097	a
012	FF	Form feed	055	7	098	b
013	CR	Carriage return	056	8	099	c
014	SO	Shift out	057	9	100	d
015	SI	Shift in	058	:	101	e
016	DLE	Data link escape	059	;	102	f
017	DC1	Device control 1	060	<	103	g
018	DC2	Device control 2	061	=	104	h
019	DC3	Device control 3	062	>	105	i
020	DC4	Device control 4	063	?	106	j
021	NAK	Negative acknowledge	064	@	107	k
022	SYN	Synchronous idle	065	A	108	l
023	ETB	End of transmission block	066	B	109	m
024	CAN	Cancel	067	C	110	n
025	EM	End of medium	068	D	111	o
026	SUB	Substitute	069	E	112	p
027	ESC	Escape	070	F	113	q
028	FS	File separator	071	G	114	r
029	GS	Group separator	072	H	115	s
030	RS	Record separator	073	I	116	t
031	US	Unit separator	074	J	117	u
032	SP	Space or blank	075	K	118	v
033	!	Exclamation mark	076	L	119	w
034	"		077	M	120	x
035	#	Number, sign	078	N	121	y
036	$		079	O	122	z
037	%		080	P	123	¦
038	&		081	Q	124	|
039	'		082	R	125	¦
040	(		083	S	126	~
041	)		084	T	127	DEL
042	*		085	U		

STARTING POINT

by Robert Penfold

Introducing the fundamentals of electronics for the constructor.



Classes of Amplification

The amplifiers considered so far in "Starting Point" have all been of the type where a transistor has been used in one of the three amplifying modes with a resistor as the collector or emitter load, as appropriate. A simple arrangement of this type is perfectly suitable for use in low level stages where powers of no more than a few milliwatts or so are involved, but the inefficiency of this class of amplifier is a severe drawback when an output power of a few hundred milliwatts or more is required.

For example, if we consider the simple output stage shown in Figure 1, this is a straightforward common emitter stage having R1 to provide base biasing, R2 as the collector load resistor, and input and output DC blocking provided by C1 and C2 respectively.

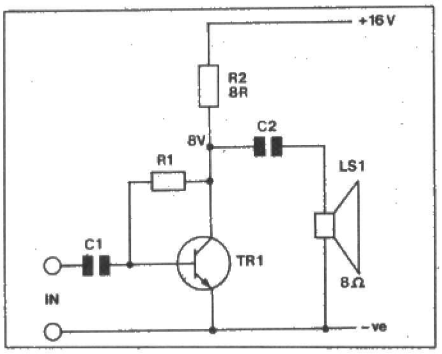


Figure 1. Simple Class A output stage.

As usual, the circuit is biased so that Tr1 has a collector potential of half the supply voltage, and with 8 volts across 8 ohm load resistor R2 there is obviously a current flow of 1 amp through R2 and Tr1. This gives an input power of 16 watts, with R1 and Tr1 each dissipating 8 watts.

The maximum output voltage from this stage is about 16 volts peak to peak, and will be a little less than this in practice since even with Tr1 switched fully on there is still likely to be a potential of about 1 volt at its collector. No practical transistor can produce a collector potential much below this figure when operating at a high collector current. We are also assuming that the circuit is driving an infinite load impedance, whereas it is in fact driving a load impedance of just 8 ohms. The load impedance is, in fact, equal to the 8 ohm output impedance of the amplifier, and this causes the output voltage to be loaded to just half the unloaded figure. In other words the maximum theoretical output voltage swing is only 8 volts peak to peak under load, and in practice would not even be as high as this. In terms of RMS output voltage this is only about 2.83 volts.

The output power of an amplifier is E^2/R where E is the RMS output voltage and R is the load impedance. In this example E^2 is equal to 8, and dividing this by the 8 ohm load impedance obviously gives an output power of 1 watt RMS. In other words an input power of 16 watts is required to give a maximum output of only 1 watt RMS!

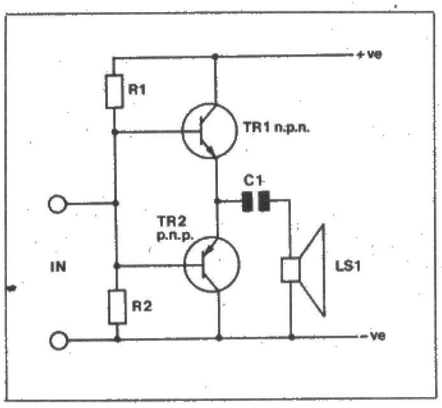


Figure 2a. Basic Class B (AC coupled) output stage.

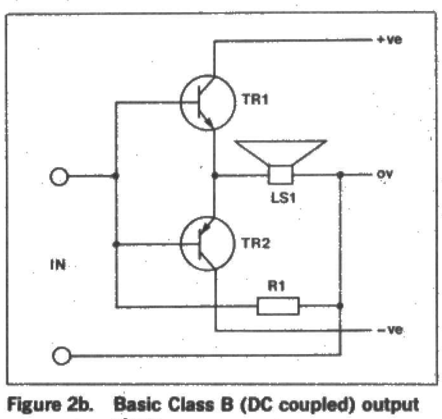


Figure 2b. Basic Class B (DC coupled) output stage.

Higher output power can be obtained by reducing the value of R2 so that the output impedance of the amplifier is reduced, and the loaded output voltage is increased. However, this would cause the input current and power to rise, and would actually decrease efficiency. Increasing the value of R2 would reduce the input current and power, but would also give a lower loaded output voltage and maximum output power, and would again actually produce a reduction in efficiency.

There are a number of ways of improving the efficiency of simple amplifiers of this general type, which are known as 'Class A' amplifiers, but the efficiency of a true Class A stage is always rather low. The disadvantages of this low efficiency are the need for a substantial and expensive power supply to give even quite modest output powers, the need to use high power components in the output stage, and the generation of a substantial amount of heat. Battery operation also tends to be a little impractical using primary cells since the high current consumption results in expensive batteries becoming exhausted at an alarming rate.

Class B Operation

Virtually all audio power amplifiers use some form of Class B operation, and Figure 2 (a) shows the basic Class B output stage on which most modern designs are based. Figure 2 (b) shows the DC coupled output version, and operation of the two circuits is essentially the same. However, the DC coupled version is a little easier to understand and we will therefore consider the operation of this circuit.

The circuit has dual balanced supplies, and the loudspeaker connects between the output of the amplifier and the 0V rail. Tr1 and Tr2 are both emitter followers and therefore each provide approximately unity gain. R1 biases the input and output of the amplifier to the 0V rail potential, and under quiescent conditions there is thus no voltage present across LS1.

If a positive input signal is applied to the circuit Tr1's emitter goes positive and Tr1 supplies power to LS1. The output impedance of the circuit is very low and despite the low load impedance Tr1 can supply virtually the full positive supply potential to LS1. Tr2 is cut off and plays no active role with a positive input signal.

With a negative input signal Tr1 is cut off and it is Tr2 that supplies power to LS1. Once again the output impedance is very low, and almost the full negative supply voltage can be delivered to LS1.

This system gives much better efficiency

than a Class A circuit since the maximum peak to peak output voltage is virtually equal to the sum of the two supply voltages, and the supply current is equal to the output current. Thus the average supply current varies in sympathy with the output, and is zero under quiescent conditions. This avoids high current consumption and heat generation under stand-by or low volume conditions, and when the amplifier is fully driven it is possible to obtain an efficiency of over 70%. This contrasts with the high continuous current consumption and low efficiency of a Class A circuit.

Quiescent Bias

In practice the circuits of Figure 2 would give very poor results due to what is termed "crossover distortion". This comes about due to the base-emitter potential of about 0.6 volts that is needed before a silicon transistor begins to conduct. This makes it necessary to have an input signal of at least +0.6 volts before there is any output signal at all! Even with an output signal from the circuit there is severe distortion as the low voltage part of the waveform is absent. A triangular input waveform as shown in Figure 3(a) would emerge from the circuit as shown in Figure 3(b).

Crossover distortion is normally overcome by incorporating some additional components at the input of the output stage, as shown in the circuit of Figure 4. Here the driver and output stages are effectively merged together, and practical designs are invariably of this type. Tr1 is the driver stage and Tr2 plus Tr3 are the complementary emitter follower output stage. The amplifier is biased by R1 and R2, and the purpose of D1, D2 and RV1 is to give a quiescent bias voltage across the bases of Tr2 and Tr3.

RV1 is adjusted so that the bias fed to Tr2 and Tr3 is just sufficient to bring them to the threshold of conduction so that Tr2 is switched on if the drive voltage even marginally positive, and Tr3 is switched on as soon as the drive voltage from Tr1 starts to go negative. In practice it is usually necessary to use a slightly higher bias than this so that under quiescent conditions there is a small but significant current flowing through Tr2 and Tr3. This is necessary due to the comparatively low gain of practical transistors when they are only marginally above the threshold of conduction, and the relatively small but nevertheless significant amount of crossover distortion that this would produce. By biasing the output devices beyond this low gain part of their transfer characteristics this crossover distortion is avoided.

It may, in fact, be necessary to use quite a large quiescent bias current through the output transistors in order to produce really low crossover distortion. Circuits of this type are generally called Class AB amplifiers, and this is simply because at low and medium output powers one transistor acts as the amplifying device and the other output transistor acts as its emitter load. This is, in fact, a form of Class A operation, and it is only at high powers that one transistor is cut off while the other drives the load, and true Class B operation is obtained. It is from this mixture of Class A and Class B operation that the term Class AB is derived.

Most practical designs use only a low quiescent bias current through the output transistors, and this is quite understandable since Class AB working obviously partially loses the advantages of Class B operation. Also, although Class AB amplifiers avoid crossover distortion this advantage is offset by an increase in other types of distortion.

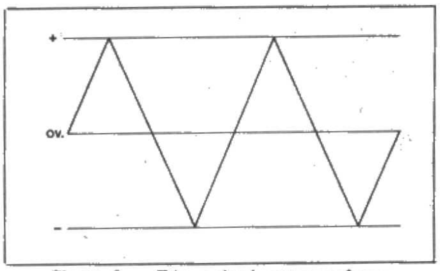


Figure 3a. Triangular input waveform.

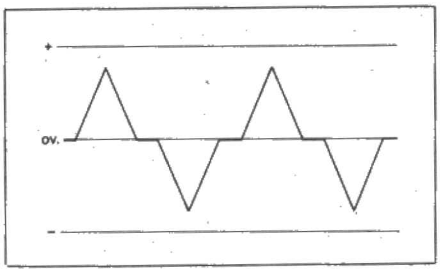


Figure 3b. Output waveform, showing crossover distortion.

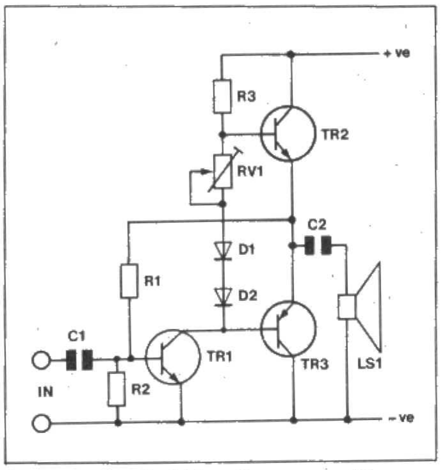


Figure 4. Practical Class B power amplifier configuration.

Practical audio power amplifiers almost invariably use a low quiescent bias plus a generous amount of negative feedback to reduce crossover distortion and other types of distortion.

Thermal Runaway

The bias voltage supplied across the bases of Tr2 and Tr3 is extremely critical, with a marginally low potential giving severe crossover distortion and a slightly high bias producing a very large quiescent current through the output transistors. The position is made worse by the heating that occurs in Tr2 and Tr3 when the amplifier has been in use for a short while. Bearing in mind that Tr2 and Tr3 will inevitably have to handle substantial power levels a significant amount of heat generation in these transistors is inevitable.

As Tr2 and Tr3 heat up, their base-emitter threshold voltage decreases, and the quiescent bias current increases. The increasing bias current produces further heating in the output devices which, in turn, gives an increase in the bias current, and this regenerative action continues until the output devices overheat and are destroyed unless suitable preventative measures are taken. This thermal feedback is called "thermal runaway".

D1 and D2 are used to prevent thermal runaway, and they achieve this by sensing the rise in temperature of the output transistors. They may actually be mounted on the same heatsink as the output transistors in order to ensure that they rapidly and properly sense the temperature changes. The voltage developed across D1 and D2 varies with temperature, and decreases as temperature is increased. This gives a strong stabilising effect on the quiescent bias current with the bias voltage automatically decreasing as the output transistors heat up.

There are other ways of providing thermal stabilisation, such as using a transistor in the amplified diode configuration, or a negative temperature coefficient thermistor. Whatever method is used the circuit must be carefully designed as there is otherwise a likelihood of over-compensation and consequent crossover distortion when the output transistors heat up, or insufficient thermal stabilisation which would simply result in slower thermal runaway!

Most low and medium power audio amplifiers these days are based on an integrated circuit, and thermal stabilisation is not a problem here since the output transistors and the temperature sensing components are on the same chip. This enables very predictable results and very accurate stabilisation to be easily obtained.

Power MOSFETs are becoming increasingly popular for use in the output stages of high power audio amplifiers, and amongst other advantages they require no thermal stabilisation. These devices have a positive temperature coefficient, like bipolar transistors, at low operating currents. However, this changes to a negative temperature coefficient at currents of more than about 80mA. In other words, with a bias current of less than about 80mA an increase in temperature produces a small increase in the quiescent bias current, but at more than about 80mA an increase in temperature results in a decrease in bias current. The quiescent bias current therefore tends to be self-stabilising, and thermal runaway cannot occur.

Class C

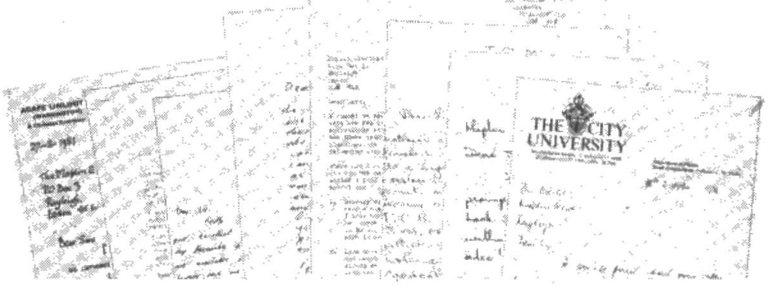
Class C amplifiers are not often encountered, and are only applicable to radio frequency circuits. With this type of amplifier the amplifying device is reverse biased so that it only conducts during quite a small part of each output cycle. The load for the amplying device must be a tuned circuit which "rings" at its resonant frequency and effectively fills-in the missing part of the output waveform. A mechanical analogy of this is the periodic striking of a bell to produce a continuous ringing sound.

The advantage of Class C operation is the very high level of efficiency that can be attained, but a lot of filtering is normally needed at the output to produce a really pure output signal.

There are other modes of operation, and Class D for example is a form of high efficiency audio power amplifier. However, these other modes of amplification tend to be quite complex and are mostly just variations on one of the operating modes already described. Class D for example, uses what is really just a Class B output stage, and it is the preceding and following circuitry that give the higher efficiency.

It is worth noting that although the circuits shown here use only a single device in the output stage, or a single device in each half of the output stage in the Class B designs, practical circuits often employ two devices in the Darlington Pair configuration or some similar arrangement. This is often necessary in order to produce a really low output impedance so that large output currents can be easily provided with only a modest drive current. ■

READERS LETTERS



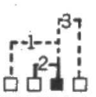
4-Pole Slide Switch

Dear Maplin,
Please forgive me if I appear to be repeating myself, only I've just bought your new magazine 'Electronics' first issue and what a surprisingly good buy it is too!
Problem is, when I turned to page 63 'Amendments to Catalogue' there is no mention of the switch I mentioned a while back, and as my previous letter probably fell on stoney ground I shall briefly recap.

FH38R 4 POLE 3 POSN SLIDE
(PAGE 279)

Having used this switch once again am convinced at this error, rather annoying and repetitive.
Connection positions should be transposed as shown:

TO READ:



A. DONALDSON
Walton-on-Thames, Surrey

We reprinted the manufacturer's data, but unfortunately, not all of it. The missing piece of data shows the position of the knob for each number. We agree that without this vital piece of information, your drawing is more logical.

Removable Price List

Dear Sir,
I have only one criticism — hopefully constructive — to make about an otherwise excellent magazine: please arrange the pages so that the "Price List" can be removed without disrupting the magazine articles. Removing the latest Price List in its entirety takes Readers Letters and the first page of the Home Security System project. In the first issue, New Books and the first page of the Universal Timer project would go. In this particular case, perhaps you could have "surrounded" the Price List with the two pages of Maplin News (pps 63/4 Issue 1), much of which applies to the Catalogue anyway.

P. HUNT
Wimborne, Dorset

Whilst I have some sympathy with your suggestion, I have to balance this with the overall look of the magazine. Breaking up Maplin News and siting it either side of the Price List makes the magazine look scrappy. Also it does not allow us to have a double-page spread to give extra impact to the article following the Price List. I would be interested to hear other people's views, but at the moment I am not sufficiently persuaded to change the layout.

Countdown Timer Circuit Wanted

Dear Sir,
As a regular reader of your magazine(s!) I write to ask if through the readers letters pages of your magazine any reader could help with the source of a published circuit for a countdown timer. There does not seem to be a dedicated chip available for this purpose nor can I find details of a suitable circuit.
There must be many uses for such a device (sports, quiz games etc, etc) — perhaps you could consider developing such a device.

I. E. SHEPHERD
Johnstone, Renfrewshire

Any offers?

Additions To Burglar Alarm

Dear Sir,
I must say that I was impressed with the excellent specification on the Maplin Burglar Alarm in the latest edition of the Maplin Magazine.
However, there are a few 'improvements' which, if they could be incorporated, would make for an even better security device.
1. PANIC SWITCHES with a latching operation that would operate the external alarm whether or not the main control was 'on' or 'off'.
2. AN AUTOMATIC RE-SET for the external alarm, that would shut the alarm off after, say, 20-25 minutes. The re-setting to take account of the 'new' condition, i.e. the 'offending' door or window remaining open etc.
3. RE-CHARGEABLE CELLS for the external alarm box, instead of dry batteries, linked to a remote battery condition monitor (i.e. LED's) that would indicate their state of charge at a glance, so that the cells could be charged before they became exhausted.
I realise that this is a tall order, but if any other reader is able to offer circuit modification to suit, I should like to hear from him/her.

M. MILLS
London SE26

If a panic switch is practicable, then details will be published in issue 4. The same goes for the alarm cut-off timer. The rechargeable cells are not practical, I'm afraid. In any case unless your alarm goes off when the mains is off you will only need to replace the batteries once every two or three years. So for the cost of a set of ni-cads, you will get ten years worth of dry cells. So we didn't think that the complication of charging cells in the external box was really worth the effort.

Ideas For The Mag

Dear Sir,
Here are a few suggestions for your new electronics magazine.
(a) Simple 7 channel Citizens Band radio.
(b) Inexpensive television space game unit featuring Invaders, UFOs, etc.
(c) Mini pocket sized alarm clock.
(d) Auto toaster cooking timer.
(e) Adaption of RK22Y, 23A, and 24B (6, 9 and 12 volt output silicon solar panels) to AC converted stepped up voltages to result in 240 volts so that it could be used on mains equipment.
P.S.: I think your magazine is helpful and very enjoyable to read.

DOMINIC LOUGHLIN
(age 11)
Chorley, Lancs

Your first three ideas would, I agree, be very interesting, but to pay for the development costs, they would also have to be saleable and frankly, there is no way a kit of parts for any of these ideas could be assembled for less than the cost of a ready-made unit in the shops. Consequently, their sales potential would be very small. We do think a kitchen timer, possibly with an add-on mains controller (for toasters or whatever) would be an interesting little project.
Unfortunately your idea for the silicon cells is not practical at all. To gain a voltage increase there must be a similar decrease in current. With the 12V panel we would require a 20-times increase in voltage and there would then be a 20-times decrease in current. Because of the inefficiencies in this kind of circuit in practice, the current would actually be much lower than this. Then we would need to drive an oscillator of some sort to convert to AC. I would think you would be lucky to end up with 1mA at 240V AC. And there's not a lot you could do with that. For example a colour TV draws about 1A from the mains, so you'd need a thousand 12V panels to run one. Clearly, an expensive proposition.

Congratulations

Dear Sir,
Another electronics magazine? NO. Congratulations on entering the field late in the day and beating the opposition hands down!
I have been a satisfied mail order customer for some time and I still marvel at the speed with which you deliver the goods. I recently received my first copy of the Maplin Mag after long deliberation on whether to fork out on yet another electronics mag — your introductory offers tipped the balance — and I am delighted. I enjoy the wide range of projects from the absolute beginner's cinche up to the more demanding Timer project. In addition your range of features has something for everybody. Keep up the good work — I can't wait for the next issue!

J. E. MABBOTT
Rhosneigr, Gwynedd

Thanks Mr Mabbott. Hope you enjoy this issue too.

What About MES56?

Dear Doug,
Thanks for the new magazine — a very useful addition to the Maplin catalogue. Could one suggest for future inclusion an article on the growing Maplin empire, and also adding to that empire with a Leeds or Manchester shop.
Normally I order from you by telephone and every time I get a reply paid envelope and order form which finish up in the rubbish bin. How about asking customers who telephone if they require these and thereby saving on costs. Also I was sorry to see the discount voucher scheme discontinued but can understand that as it operated it could be costly to administer. Could I suggest a) A discount scheme for quantity orders of the same part; b) A discount for large orders say over £30. Maplin are very competitive, compared with trade component suppliers, on a one-off basis but not on large quantities.
One of my main interests in electronics is electronic organs. Some three years ago I started building an MES53 and have enjoyed this project but feel that further developments on this organ have been pushed to one side to develop the Matinee. However, when I heard the MES organ at Breadboard '80 it had certain extra effects so you must have come some way to developing MES56 and 57 mentioned in the last catalogue but not the most recent. When can I look forward to more developments on the MES organ? I look forward to hearing.

I. D. MANZIE
Skipton, N. Yorks

You will be pleased to hear that we are considering opening a Maplin store in Manchester, once our Birmingham shop (opening soon — the announcement will be in the Birmingham "Evening Mail") is open. Frankly, it's cheaper for us to have one pile of packs of order form and envelope and just put one in every order, than to have two piles, one without envelope, and sort the orders; bearing in mind that this part of the packing is done very quickly: on an average day the team of packers completes an order every 20 seconds.
We have on many occasions considered quantity discounts, but it is an added complication to our throughput which is now a very speedy and efficient animal. We may implement a discount scheme one day, but not until we are certain we can cope at our usual speed, with the extra business this would generate.
We are still hoping that we can fit MES56 into our schedule soon. Although most of the design work was completed a long time ago, there is a considerable amount of documentation still to be done. At the present time it seems unlikely that MES57 will be produced.

Ultrasonic Burglar Alarm

Dear Sir,
I enjoyed the first publication of your electronics magazine.
Could you inform me if you have any articles in future editions relating to the building of Ultrasonic Burglar Alarms, if not could you suggest any alternative reading matter on this subject.

M. J. ILSLEY
Bournemouth

Yes. You'll be pleased to hear that an ultrasonic intruder detector for use on its own or with our Home Security System will be featured in our next issue.

Continued on page 54.

What About An Article On PCB's

Dear Sir,
I have just received the first two issues of your Maplin Mag with which I am greatly pleased. One main advantage to me is that most, if not all, of the components and hardware can be purchased through Maplin, whereas in some of the other electronics magazines you have to search to find catalogues that have maybe one small item that another catalogue has not got in stock.
As I am a bit of a newcomer to electronics I found your 'How To Solder' article in the first issue most useful. I would be pleased to see a similar article on how to make PCB's.

S. BURDEN
Leicester

By an amazing coincidence this month we have an article describing how to make PCB's and a special offer to go with it. How's about that then?

CB Article A Big Help

Dear Sir,
I would like to say that I think your March issue of the magazine was a big improvement over the first issue, much more interesting in every way. One particular item that really made my day was your comment on ground planes for CB. I found how difficult it was to obtain an antenna for loft installation (I don't know why dealers are not stocking this line, because we all do not have gardens to put up a mast). However, I purchased a "Big Chief" TBR140 and put it out of a skylight but could not get the SWR down until I read your article. I purchased 10 metres from you of the 32/.02 wire and threw two and a bit metres out from each corner of the skylight connected to the base of the antenna and I am pleased to say I got the SWR down to 1.2. Thanks a lot. I have since had 'copy' from here to Winter Hill, Liverpool, Southport and, believe it or not, Prestatyn, N. Wales. One other point I would like to mention is why do you not cater for items or kits printed in E.E. or P.W. magazines. Recently I wished to build a PSU but found I could not get half of the items from you, so I decided on buying the complete kit from another firm offering a speedy service. How sorry I am. It was over three weeks for delivery, not counting telephone calls at standard rate, five items were missing, more phone calls and letters and then when assembling I found a couple of the items were of the incorrect value or type. These I am now ordering from you. I must say that you do give a wonderful service and for this I thank you very much.

T. E. FLINT
Skelmersdale, Lancs

It just isn't practical for us to stock all the parts needed for all the projects in all the magazines. Although we often notice magazines stating that such-and-such a part is only available from a particular supplier when in fact we sell it too; so it's always worth checking.

Interfacing Microprocessors

Dear Sir,
My compliments on a very interesting and well-balanced magazine. There may be nine others on the news stands but so far as I am concerned they will stay there!
My interest is mostly in digital electronics, and I would welcome projects relating to the interfacing of microprocessors to the "outside" world. I am sure that if you published a few well-chosen projects for, say, the ZX81 or the BBC micro (not to mention the Atari!) then sales would benefit and yet more readers would be made happy! Perhaps if you publish this letter this idea will be confirmed?

A. J. BYTHEWAY
Great Missenden, Bucks

Your comments are much appreciated by everyone here at Maplin. We agree that interfacing is a very interesting subject at the moment and we have several articles and projects along these lines lined-up for the future.

Four Questions

Dear Sir,
Would you please print this in the Maplin Mag:
Will Maplin be stocking the BBC Microcomputer System?
Why are there no blue LEDs?
Will Maplin please consider stocking: Casio calculators and watches + batteries, TDK tapes and ready made hi-fi synthesiser equipment for those of us who aren't electronic geniuses?
How about a review of the BBC Microcomputer System in the Maplin Mag?

J. G. ASHDOWN
Grays, Essex

1. We do not have any plans at present to sell the BBC micro. Truthfully, we are only interested in selling genuine home computers, not business machines. The BBC micro does not and will never have the kind of software backup being built up by Atari and Commodore and so in our opinion will never be a genuine home computer.
2. Blue LED's have been available for some years, but they are difficult to make and Siemens for example have been selling them for £80 each. Prices have recently fallen owing to use of a different material and within a few months we expect blue LED's to be available for about £5 each. Even at that price though, it's doubtful that we would consider stocking them.
3. We certainly could stock all the items you mention, but with postage costs we'd almost certainly be dearer than the electrical shop just down the road. The big chain stores buy so many units that their prices are very competitive and I don't think we could compete.
4. We are not planning a review of the BBC micro at the moment.

Maplin Mag Should Be Monthly

Dear Sir,
I would like to endorse C. W. Dudley of Kent, who mentioned it was a pity the Maplin Mag was not a monthly. Surely it would be possible to operate a monthly system, only entering the price list every three months. Also, I feel that the quality of the articles in this periodical are of a much higher standard than those of a large periodical such as Practical Electronics (who's mag I stopped buying in favour of Maplin!).
Unfortunately, I note there is a series called "Basically BASIC", I have both the December and March issues, but did this series begin before, and if so, how could I obtain "back numbers" of the series only.
Carry on the good work, Maplin.

I. GREGORY
Hadfield, Cheshire

A magazine without advertising gets most of its revenue from subscriptions. Each issue costs a lot of money to produce and there's no way we could reduce the price from 60p a copy. There is no doubt that our level of subscriptions is as incredibly high as it is due to the fact that it costs only £2.40 a year. If we went monthly this would rise to £7.20 a year, and we fear that we would see a substantial decline in subscriptions at that level. So until we can think of some other way of financing the magazine I'm afraid we have to stay quarterly.
Basically BASIC has been a very popular series. Parts 1 to 9 appeared in the March to November 1981 issues of "Electronics and Music Maker", back issues of which are still available. However, when the series is completed we hope to republish the whole thing in book form.

MES56 Again

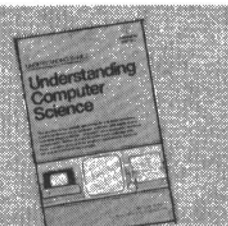
Dear Sir,
Congratulations on your 1st and 2nd editions of your magazine. It was very nice to see an interest taken in the Matinee update, which must prove very useful to readers building that organ. Would it be possible to do the same thing with the MES50 series organ which seemed to come to an abrupt halt with MES55. There must be more people than just yours truly still trying to build this organ, or even current owners who would like the goodies promised in the yet to be published MES56, nor the apparently now still-born MES57. This is quite an expensive project for most of us (£1,200+) for it not to have a piano voice etc.
Or has some enterprising reader added this on and would like to tell us how he did it? Personally, I am still trying to work out what could go on the "Y" pins on the tone boards.
Good luck for the future and really keep the musical side going.

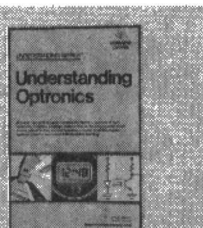
N. SYLVESTER
Bexhill-on-Sea, Sussex

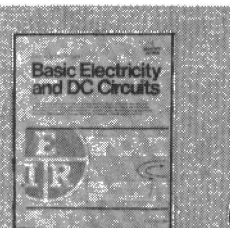
See the answer to Mr Manzie's letter. The Y pins on the tone boards were provided in case they were needed for the couplers, but they are not required at this stage.

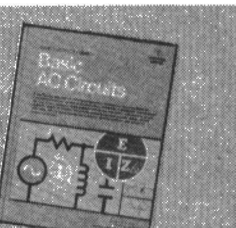
TEXAS INSTRUMENTS DATA LIBRARY

(continued from page 53)









Understanding Computer Science
by Roger S. Walker
Explains the science of how people use computers to solve problems. Covers the fundamentals of hardware, software and applications including program design, languages, data structures and resource management. Written in easy-to-understand language with basic concepts illustrated by practical applications. 1981. 278 pages. 208 x 132mm. Illustrated.
Order As WA25C (Underst Comp Science) Price £4.95*NV*

Understanding Optronics
by Larry B. Masten and Billy R. Masten
What is light and where does it come from? Starting with these questions the book goes on to explain why and how opto-electronic devices work. Such devices as LED's, liquid crystal displays, CRT's etc. Fibre optic links and lasers are also explained.
1981. 272 pages. 208 x 132mm. Illustrated.
Order As WA26D (Understanding Optronics) Price £4.95*NV*

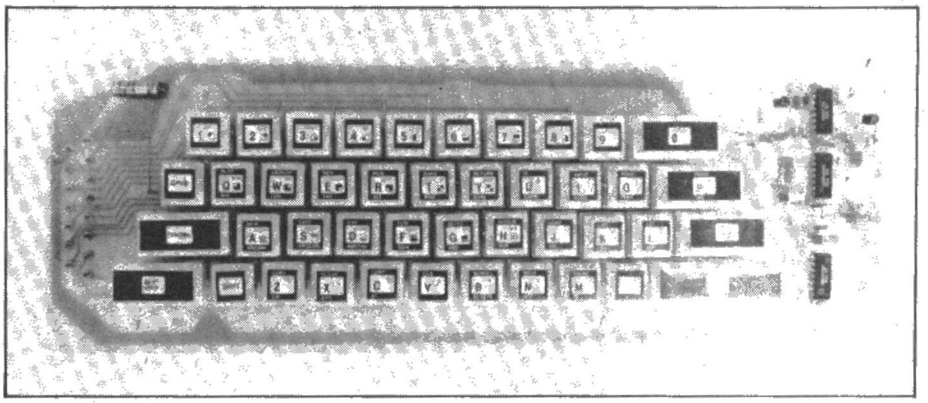
Basic Electricity and DC Circuits
by Ralph A. Oliva and Charles W. Dale
A step by step approach for the beginning student. The book covers first concepts and terms, basic mathematics required in the study of basic electricity and direct current circuits. This is a comprehensive text including clearly stated objectives and exercises with answers and is ideal for self-paced individualised learning.
1979. 924 pages. 234 x 184mm. Illustrated.
Order As WA27E (Basic Elec & DC Ccts) Price £12.50*NV*

Basic AC Circuits
by Stanley R. Fulton and John Clayton Rawlins
Continuing the series begun in 'Basic Electricity and DC Circuits', this book goes on to explain simple and complex AC circuits. As with the first book, it is a very comprehensive text and each new concept is carefully explained as it is introduced.
1981. 560 pages. 234 x 184mm. Illustrated.
Order As WA28F (Basic AC Circuits) Price £10.95*NV*

ZX81 KEYBOARD Continued from page 4

delaying the operation of IC1c. When it finally operates, it turns on IC3c which connects 'function' in the keyboard matrix. These time delays are provided to ensure that the 'shift' connection occurs before the 'graphics' or 'function' connection as required by the ZX81.

When S33, the 'shift lock' key is operated, the output of IC1e goes high. C3 and R4 are anti-bounce components. IC2a now operates which switches on IC3b via D3 and TR2 which causes LED2 to light. Re-operating S33 causes IC2a output to go low which releases IC3b and extinguishes LED2. ■



PARTS LIST

Resistors — all ¼W 5% carbon unless specified			
R1	150k		(M150K)
R2,3,6	1M	3 off	(M1M)
R4,7	100k	2 off	(M100K)
R5,8,9	10k	3 off	(M10K)
R10,11	560R	2 off	(M560R)
Capacitors			
C1	390nF polycarbonate		(WW48C)
C2,3,4,5	100nF polycarbonate	4 off	(WW41U)
C6	10nF polycarbonate		(WW29G)
C7,8,9,10	100nF minidisc ceramic	4 off	(YR75S)
C11	100uF 25V axial electrolytic		(FB49D)
Semiconductors			
D1-6	1N4148	6 off	(QL80B)
LED1,2	LED red	2 off	(WL27E)
TR1,2	BC548	2 off	(QB73Q)
IC1	40106BE		(QW64U)
IC2	4027BE		(QX16S)
IC3	4066BE		(QX23A)
Miscellaneous			
JK1	Plug 3.5mm plastic		(HF80B)
S1-44	Keyswitch	44 off	(FF61R)
	Keytop 1-position	37 off	(FF62S)
	Keytop 2-position	5 off	(FF63T)
	Keytop 3-position		(FF64U)
	Keytop print ZX81		(XH58N)
	ZX81 ext. keyboard pcb		(GA83E)
	Tinned copper wire 24 swg	2m	(BL15R)
	Adaptor L		(RK27E)
	RA flexiconnector 5-way		(RK28F)
	RA flexiconnector 8-way		(RK29G)
	Flexicable 7-way		(RK30H)
	Flexicable 10-way		(RK31J)
	Cable single black	½m	(XR12N)

A complete kit for this project excluding a case is available.
Order As LW72P (ZX81 Keyboard Kit) Price £19.95
A case is also available.
Order As XG17T (ZX81 Keyboard Case) Price £4.95

25W STEREO MOSFET AMP Continued from page 44

PARTS LIST

Resistors — all ¼W 5% carbon unless specified			
R1,6	68k	2 off	(M68K)
R2,7,37,48	1k	4 off	(M1K)
R3,8	22k (1%)	2 off	(T22K)
R4,9	270k (1%)	2 off	(T270K)
R5,10	100k	2 off	(M100K)
R11,12,40,41,51,52	100R	6 off	(M100R)
R13,16,17,20	470k	4 off	(M470K)
R14,18	1k2	2 off	(M1K2)
R15,19	22k	2 off	(M22K)
R21-24,27-32	2k2	10 off	(M2K2)
R25,26,39,50	15k	4 off	(M15K)
R33,44	47k	2 off	(M47K)
R34,45	56k	2 off	(M56K)
R35,36,46,47	3k9	4 off	(M3K9)
R38,49	33k	2 off	(M33K)
R42,43,53,54	10R	4 off	(M10R)
R55,56	220R (½W)	2 off	(S220R)
R57,58	820R	2 off	(M820R)
R59	2k7		(M2K7)
RV1-4	100k horizontal sub-min preset	4 off	(WR61R)
RV5,6	10k horizontal sub-min preset	2 off	(WR58N)
RV7	4k7 log dual pot		(FX08J)
RV8,9	47k lin dual pot	2 off	(FW87U)
RV10	10k lin pot		(FW02C)
Capacitors			
C1,5	68pF ceramic	2 off	(WX54J)
C2,6,25,31	10uF 35V PC electrolytic	4 off	(FF04E)
C3,7	10nF 1% polystyrene	2 off	(BX86T)
C4,8	3n9 1% polystyrene	2 off	(BX63T)
C9	100uF 40V axial electrolytic		(FB50E)
C10,11	10uF 16V tantalum	2 off	(WW68Y)
C12,13,23,29	10pF ceramic	4 off	(WX44X)
C14,15,18,19	68nF polycarbonate	4 off	(WW39N)
C16,20	4n7 polycarbonate	2 off	(WW26D)
C17,21,24,26,30,32	47pF ceramic	6 off	(WX52G)
C22,28	4uF 16V tantalum	2 off	(WW64U)
C27,33	100nF polyester	2 off	(BX76H)
C34,35	1000uF 25V axial electrolytic	2 off	(FB49D)
C36,37	4700uF 40V axial electrolytic	2 off	(RK26D)
Semiconductors			
D1-4	1N4148	4 off	(QL80B)
D5,6	BZY88C15V	2 off	(QH18U)
LED1	Chrome LED small		(YY59P)
BR1	Bridge S04		(QL10L)
TR1,2,3,8,9,10	BC212L	6 off	(QB60Q)
TR4,5,11,12	BC182L	4 off	(QB55K)
TR6,13	2SK133	2 off	(QQ36P)
TR7,14	2SJ48	2 off	(QQ34M)
IC1,2,3	LF353	3 off	(WQ31J)
Miscellaneous			
S1	Rotary mains switch		(FH57M)
S2	Rotary 3-pole 4-way switch		(FH44X)
SK1,2,3	PC DIN socket 5-pin 'A'	3 off	(YX91Y)
SK4,5	PC DIN socket 2-pin	2 off	(YX90X)
JK1	DPDT jack socket		(BW80B)
T1	Toroidal transformer 22V 80VA		(YK18U)
FS1,2,3	2A antisurge fuse	3 off	(WR20W)
	Safuseholder 20mm		(RX96E)
	Rubber boot		(HL51F)
	Fuse clips	4 off	(WH49D)
	Mica insulator T03	4 off	(WR24B)
	Small thermpath		(HQ00A)
	Stereo amp heatsink		(RK25C)
	Stereo amp pcb		(GA71N)
	Stereo amp switch pcb		(GA78K)
	Stereo amp chassis		(XG15R)
	Stereo amp woodwork		(XG16S)
	Cabinet feet	1pk	(FW19V)
	Grommet small	2 off	(FW59P)
	Knob K44	3 off	(HB39N)
	Knob K45		(HB40T)
	Knob K46	2 off	(HB41U)
	Veropin 2141	28 off	(FL21X)
	Bolt 4BA 1in	4 off	(BF04E)
	Bolt 6BA ¼in	5 off	(BF05F)
	Bolt 6BA ½in	8 off	(BF06G)
	Nut 6BA	13 off	(BF18U)
	Washer 6BA	12 off	(BF26D)
	Tag 6BA		(BF29G)
	13A mains plug		(RW67X)
	Min mains cable	2m	(XR01B)
	Hook-up wire yellow	1m	(BL10L)
	Tinned copper wire 24 swg	1m	(BL15R)
	Systoflex 2mm black	10cm	(BH06G)

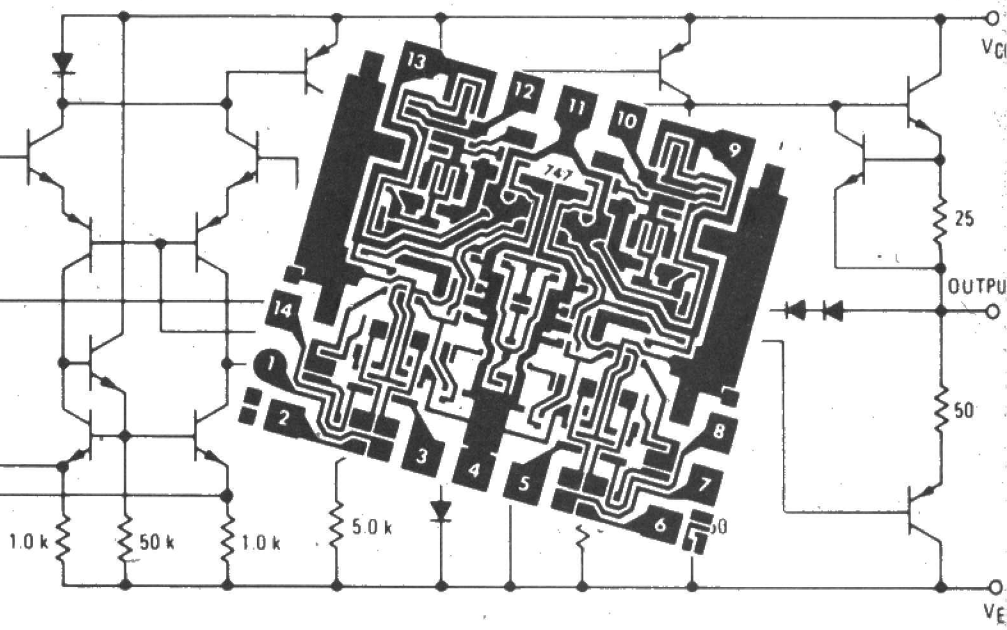
A complete kit of all the parts listed above is available.
Order As LW71N (25W Stereo MOSFET Amp Kit) Price £49.95

WORKING WITH OP~AMPS

by Graham Dixey C.Eng., M.I.E.R.E.

Part 2

The first part of this series introduced the op-amp and gave an insight into its versatile nature. Now its specific role as a waveform generator will be illustrated. The most useful waveforms are undoubtedly the sine-wave, square-wave, triangle and sawtooth, all of which can be produced by this device. As a result, it will be appreciated that what is being demonstrated is not only its linear use for generating sine-waves but also its switching mode when giving a square-wave output.



The Astable Multivibrator

This circuit (Figure 1) looks unfamiliar when compared with the discrete component equivalent. One obvious difference is that there is only one RC 'timing' circuit (R1, C1). This saves components but means that the mark to space ratio of the square-wave output will always be 1:1. Adjusting either R1 or C1 only changes the frequency. The resistors R2 and R3 form a potential divider between the output and the 0V line so that, whatever level exists at the output (+Vs or -Vs), the non-inverting (+) input is always at a fixed proportion of it.

The clue to the mode of operation lies in this last statement. The non-inverting input is held at a fixed reference voltage, either positive or negative, while at the instant that power is applied to the circuit, the inverting input is at 0V since C1 is uncharged. As a result, the output goes to either +Vs or -Vs (it does not matter which, say +Vs), in which case the non-inverting input will be at a potential equal to +Vs [R3/(R2 + R3)]. Since there is zero phase-shift between this input and the output, the latter level is effectively 'latched' to +Vs. The circuit is now resting in one of its two 'quasi-stable' states and will do so until something upsets the equilibrium. This 'something' will occur when the exponentially rising voltage at the junction of R1 and C1 reaches the potential of the non-inverting input. Then, as this exponential voltage just becomes slightly more positive than the latter potential, the circuit will start to change state. The op-amp's very high gain ensures that the output switches rapidly from +Vs to -Vs and the potential at the non-inverting input will now reverse its polarity, latching the circuit into the new state.

The current flowing in R1 also changes direction so that the potential of the inverting input begins to fall exponentially from +Vs [R3/(R2 + R3)] towards -Vs. However, when it reaches -Vs [R3/(R2 + R3)], the circuit switches back into its original state and the cycle repeats indefinitely.

The time for which the circuit remains in one state is governed by the time constant of R1 and C1 and the voltage at the junction of R2 and R3. Frequency can, therefore, be controlled in a number of ways: by using a potentiometer for R1 and/or switching the value of C1 to give several ranges, or using a resistor chain with a potentiometer instead of R2 and R3, so varying the point in time at which the circuit changes states.

With the exponential law of growth as a basis, it is a fairly easy matter to derive an expression for frequency in terms of R1, R2, R3 and C1, thus stating precisely how frequency depends upon these circuit constants.

The time between instants of switching is found to be given by:

$t_s = C1.R1.\log_e [1 + (2R3/R2)]$

and $f = 1/(2t_s)$

C1(nF)	Frequency (Hz) Measured	Calculated	Error
10	1190	1371	-13%
47	290	292	-0.7%
100	143	137	+4.4%
220	65	62.3	+4.3%
470	30.8	29.2	+5.5%
1000(1u)	14.3	13.7	+4.4%

Table 1. Frequency vs. timing capacitor value for the circuit shown in Figure 1.

Having derived this expression for frequency, the next step was to verify it. Close tolerance resistors (5%) were used for R1, R2 and R3 and values of C1 were set on a decade capacitor box, so as to give the results some credibility. The values chosen for the resistors were R1 = R2 = 100k and R3 was 22k. The results obtained are shown in Table 1, which also includes the calculated values of frequency and the percentage errors. Except at the highest frequency, the errors are within acceptable limits. Therefore, for generators up to a few hundred Hertz, the formula can be used with confidence.

A limitation of the 741 is its inability to switch rapidly between opposite states. This limit is expressed in op-amps by the 'slewing rate', which is given in V/us. Figure 2 shows that slewing rate is simply the slope of voltage/time as the output tries to swing from one saturation level to the other. For the 741 the maximum slewing rate is usually quoted as 0.5V/us so that, with a ±15V supply, a complete transition from, say, -15V to +15V cannot be achieved in less than 30 x 0.5 = 15us, in the best case. Since switching circuits are being discussed, it is as well to be aware of possible limitations. For example, the astable circuit of Figure 1 while producing an acceptably square waveform at 1kHz, showed a marked slope on the leading and trailing edges at 5kHz.

Figure 3 shows a slightly modified form of

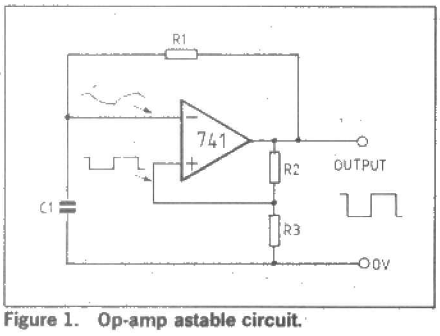


Figure 1. Op-amp astable circuit.

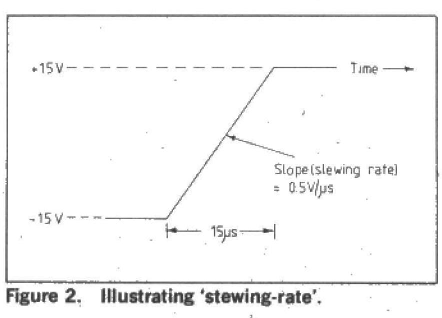


Figure 2. Illustrating 'stewing-rate'.

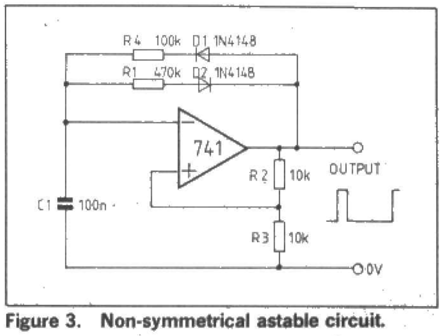


Figure 3. Non-symmetrical astable circuit.

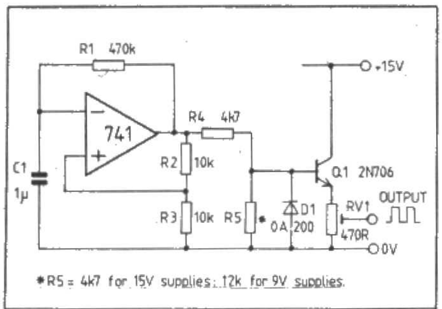


Figure 4. A 1Hz TTL generator.

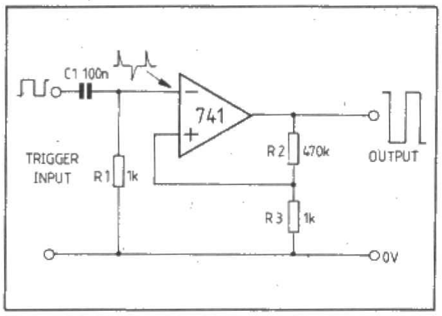


Figure 5. Op-amp bistable circuit.

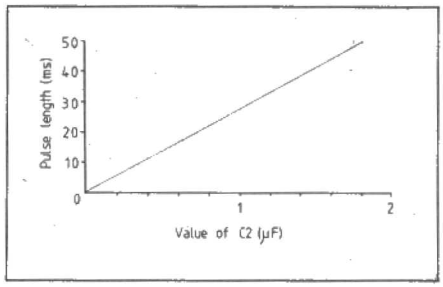


Figure 7. Pulse length graph for monostable circuit shown in Figure 6.

the astable circuit, in which the restriction of a unity mark to space ratio has been lifted. This is achieved by placing diodes D1 and D2 in the feedback paths so that the polarity of the output voltage selects which of the feedback resistors is in circuit on a particular half-cycle. This gives two time constants which are quite independent of each other — R4, C1 on positive half-cycles and R1, C1 on negative half-cycles. With the values shown this gives a short mark and a long space of 11ms and 52ms respectively.

A 1Hz TTL Generator

For digital experiments a low frequency square-wave generator is very useful, for example, for testing counters and shift registers. An output at about 1Hz is slow enough to allow events to be observed with ease and, using the op-amp astable circuit, a frequency of this value is easily achieved without the need for excessively large capacitor values.

The design is straightforward. As a starting point, let R2 = R3 = 10k (quite an arbitrary choice, which could be adjusted later if necessary). The only other components to be decided now are the timing components and it is convenient to choose a value of capacitance first, then work out the corresponding resistor value; this allows greater freedom of choice in component values. The largest value of non-electrolytic capacitor is about 1uF, so this value is used with the previously derived formula to obtain the resistor value. The formula then looks like this:

$t_s = 0.5 = 10^6 \times R1 \times \log_e$ (at 1Hz t_s = 0.5 secs.)
from which R1 = 455K

The nearest preferred value is 470k, which actually gives a frequency of 0.97Hz (neglecting component tolerances), which should certainly be close enough for most purposes. In fact, when the circuit was wired up, using 5% resistors and a 10% polyester capacitor, the error from the design value of 1Hz was too small to measure.

The next step, after getting the circuit to perform at the right frequency, is to make it TTL compatible, which means converting a ±14V swing about 0V (the output does not quite reach 15V) into a wholly positive 5V square-wave. A few additional components lead to the final circuit of Figure 4, which shows the attenuation of the op-amp output (R4 and R5) to a total swing of about 6V, this then being 'clamped' to 0V by the action of Q1, which also 'buffers' the output to provide enough drive for a number of TTL circuits. Diode D1 also has a clamping action, but its true purpose is to protect the base-emitter diode of Q1 against excessive negative V_{BE} on negative going output swings of the op-amp. The emitter resistor of Q1 is a potentiometer (preset) so that the amplitude of the output can be adjusted to precisely 5V.

Obviously the generator could be made to produce a range of frequencies by switching different values of R1 or C1.

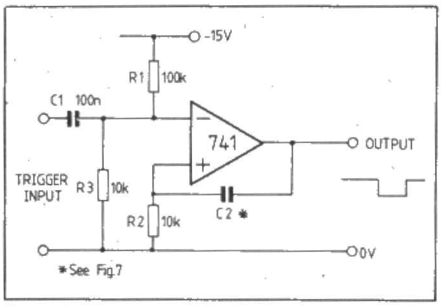


Figure 6. Op-amp monostable circuit.

The Bistable Multivibrator

Bistable action may not normally be associated with the op-amp, i.e. a circuit which is capable of resting indefinitely in one of two stable states. But, as was seen with the astable circuit, feedback from the output to the non-inverting input, will latch the circuit into a state of either positive or negative saturation. If, meanwhile, the inverting input is held at 0V, the circuit stays in this state until a trigger of some sort causes a change of state. This trigger is applied to the inverting input and the only stipulation is that its peak value must exceed the voltage at the non-inverting input; the circuit will even trigger on sine-wave inputs.

Figure 5 shows such a circuit. The inverting input is held at 0V by resistor R1 while the non-inverting input is taken back to the junction of the divider R2 and R3 across the output. Thus, depending upon the current state of the circuit, the bistable is latched into this state by a voltage at the non-inverting input equal to ±R3/(R2 + R3) x output voltage. For the values given and a ±15V supply, this voltage is (1/471) x 14, which is approximately 30mV, more than enough to take the circuit into saturation.

The trigger input is capacitively coupled to the inverting input by C1 which, with R1 differentiates the input if it is a pulse or square waveform. This action produces a series of alternate positive and negative trigger pulses which, coinciding as they do with the leading and trailing edges of the original square-wave input, mean that the output is at the same frequency as the input but reversed in phase and of larger amplitude. There is no 'divide-by-two' action and the circuit acts effectively as a 'pulse amplifier'.

This bistable circuit is not particularly fast; frequencies up to about 300Hz give a good square-wave output but, thereafter, the risetime suffers markedly.

Returning to the absence of an inherent divide-by-two action, this limitation can be removed if R2 is replaced by a parallel RC combination consisting of a 1M resistor and a 100nF capacitor, and R3 is replaced by a 470k resistor. The 100nF capacitor introduces a time constant whose purpose is to ensure that, when the circuit is initially switched, say, by the leading edge of a square pulse, it does not change state again on the trailing edge of that pulse but 'waits' for the leading edge of the next pulse. The value of 100nF is large enough for pulses up to 50ms in length but needs to be increased for longer pulses.

The Monostable Multivibrator

This, the last of the 'trio' of multivibrator circuits, has one stable state (in which it rests until triggered) and one 'quasi-stable' state (in which, after triggering, it remains for a pre-determined time, decreed by circuit constants). Although monostables can be realised with discrete components or obtained in TTL integrated circuits, it may now be appreciated that this circuit can also be produced with the ubiquitous op-amp. In this form it appears in Figure 6.

For a monostable to exist in a stable state, there must be a bias holding the circuit in that state. This bias is provided by taking the inverting input to -15V through resistor R1. The output of the op-amp is, therefore, normally in positive saturation. It is then triggered into the quasi-stable state by a square-wave or pulse input. This is differentiated by C1 and R3, only the positive pulses produced having any effect on the circuit. As a result, the circuit switches over to negative saturation where it is held by the large negative potential instantly coupled back to the non-inverting input by C2. Of course, this state cannot be sustained for long because, at this initial instant, the full negative supply voltage exists across R2 so that a charging current flows through R2 and the potential of the non-inverting input rises exponentially towards 0V. When it reaches the same value of negative voltage as at the inverting input (about -1.4V), the circuit switches back to positive saturation.

The time constant for the recovery is CR, R2 and it is possible to derive a formula for the length of the positive pulse produced at the output as a result of this action. However, in this circuit, unlike the astable, there is a linear relationship between pulse length and capacitance value so that a useful graph can be plotted between these two quantities (Figure 7). This covers a range of pulse lengths from 0 to 50ms, corresponding to values of C2 in the range 0 to 2uF. Obviously the range can be extended further by using higher values of C2 or a higher value of R2.

This type of circuit functions as a 'pulse-stretcher'; a short pulse is used to generate a much longer pulse. Or it can be used as a regenerator of pulses since the input waveform is not too critical provided that it can cause the required change of state, but the output pulse will always be of good square form.

As waveform generators, these multivibrators all generate square-waves in one way or another; each has its own use. Op-amps can also be used to generate 'derived' waveforms, such as the triangle and sawtooth; they can also be used in sine-wave oscillators. Generators of these types will be the subject of the next article. ■

ATARI COMPUTER NEWS *by Graham Daubney*

This has been a very busy period for those of us involved in computers here at Maplin. I'm sure that most of you will have heard by now that Ingersoll are no longer handling Atari products in the U.K. and that all Atari products are now being distributed by Atari themselves.

The change-over has been in the air for some time and I first heard rumours on the grapevine just before Christmas. Obviously a major change of this nature took several months for the parties involved to negotiate and the news was made official during March.

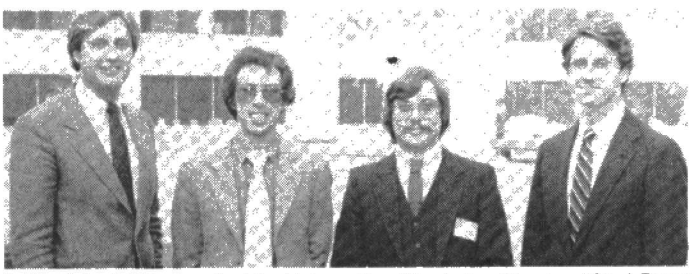
We are pleased to see that the computer press are now taking the Atari seriously and there are many articles and features lined up for future issues.

The move made by Atari to distribute their own product means several things, firstly and most importantly, a number of facilities are being set up to support the machine both for hardware and software areas. This does not directly affect you as a customer, but indirectly it has a great bearing on the Atari's future in this country as it offers both software houses and developers assistance and better backup for the U.K. retailers.

You may have already noticed a new TV campaign on the VCS games console and due to start shortly is a large scale support program for the home computer system as well.

Atari Program Exchange software will be on sale in the U.K. by mid-May which is good news as although many of these titles are available from some locations in the U.K., the prices are at present a little inflated due to importation in small quantities.

I feel that the next quarter will see a maturing of the Atari market and from the discussions that we've had with Atari I can assure you that this move will be for your benefit and that Atari mean business.



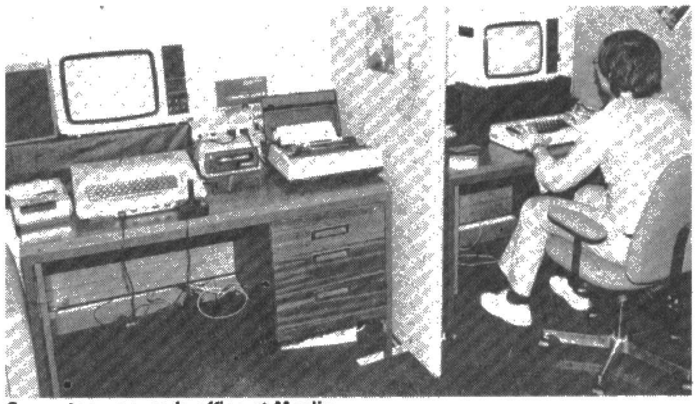
Left to right: Jeff Burton, Assistant International Marketing Director of Atari; Roger Allen, Managing Director of Maplin; Graham Daubney, Computer Manager of Maplin; Fred Mitchell, International Sales Director of Atari pictured in Atari's spectacular headquarters at Sunnyvale, California.

Atari in California

Besides all the Ingersoll-Atari goings-on, this quarter has seen many other activities here at Maplin. In January I made a further trip to California to visit the C.E.S. show in Las Vegas and also to Sunnyvale the birth place of Atari. During this trip I found many new items of software both from Atari and third party software developers. Some of these we have added to our extensive list already, but many more are planned. At the C.E.S. show I was given a sneak preview of both Pac-Man and Centipedes cartridges that are to be launched by Atari in the second quarter (remember you have to add 3 months because Atari calculate their launch dates whilst sitting in a time slip!!!).

The Atari 800 training room at Sunnyvale, California.

Whilst at Sunnyvale I visited the International Marketing Division and discussed the needs of the U.K. market in some depth. Atari's offices have to be seen to be believed, with fountains galore and very pleasant settings to work in. Further to those meetings I was able to meet the User Group Support Division and register our Users Group.

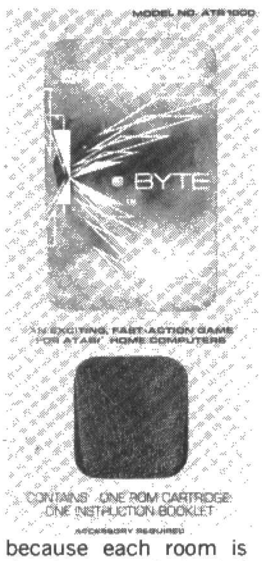


Computer manager's office at Maplin.

Atari Users Group

February saw three of us here late in the evenings writing the first issue of the user group mag. We now have over 300 members and are getting some very valuable feedback as to what you want the user group to offer.

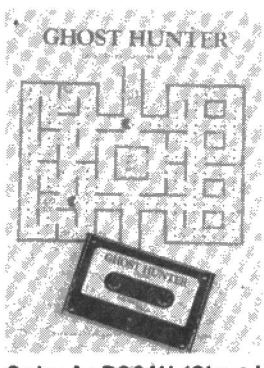
March saw the installation of a new member of staff in our sales office to deal with your machine enquiries and problems and the arrival of a VIC 20 in the office!



K-razy Shoot Out

Whilst in America, a new cartridge for the Atari computer systems was launched. The difference with this cartridge is that it was not developed by or manufactured by Atari. K-razy Shoot Out is the first third-party cartridge to be launched for the machine and won't be the last by all accounts. K-razy Shoot Out is a fast action game for one player. You are trapped in a series of rooms, with nasty little robots who shoot at you and converge on you. Points are scored by first staying alive (not easy I assure you) and secondly by shooting all the robots in the room. Problem is that when you have cleared a room and have run out, another room appears with more of the deadly assassins and, yes, you guessed it this time they shoot faster and move faster. If any of you get past the sixth room you will be doing very well! The graphics on this game are very good and because each room is randomly generated it doesn't allow the development of a 'technique' and this leads to many frustrated hours of fun, but be warned this game is totally addictive.

Order As BQ63T (K-razy Shoot Out) Price £29.95
See outside back cover for details.



Ghost Hunter

Another game based on the ever popular maze chase theme has been launched called Ghost Hunter. The main advantage of this version over previous maze chase games is that it gives you many options and choices. The layout of the maze is selectable and also you may have two players 'head to head' i.e. both in the maze together. This adds a lot of cunning and much hostility as you compete together against the marauding ghosts.

Order As BQ64U (Ghost Hunter) Price £24.50
See outside back cover for details.

ATARI VIDEO GAME

Latest Cartridge Details

This month, details of three new cartridges.

Warlords

For one to four players using paddles. Note that a second pair of paddles is needed for three or four players. The cartridge contains 23 games. You are one of four Warlords behind your castle wall. You must break down your opponents castles by firing fire-balls, then you can aim to hit the Warlord himself. There are four sets of five games. In each set, the first game is for one player, the second for two, third for three, fourth for four and the fifth game is for two players controlling two castles each.
In the first set of games, the ball speed is fast and the shields catch the balls, whilst in the second set the ball speed is slow. In the third set the ball speed is fast, but the balls ricochet off the shields and in the fourth set the ball speed is slow again. Games 21 to 23 are special versions for four, three or two children respectively. You will find that four-player games are terrific because the action is fierce and extremely competitive.

Order As AC44X (Warlords) Price £29.95

Pac-Man

For one or two players using joysticks, this game cartridge contains eight games. Pac-Man moves around a maze eating the video wafers. Four ghosts chase him and try to eat him up. However, located in the maze are four power pills, which when eaten by Pac-Man allow him to eat the ghosts.
In games 1, 2, 7 and 8 Pac-Man moves slowly whilst in the remainder, he is fast-moving. In games 1 and 5 the ghosts move at jogging speed, in games 2 and 6 they move at running speed, in games 3 and 7 at crawling speed and in games 4 and 8 at walking speed. Games 3 and 7 are ideal for children, whilst game 6 is the most difficult variation.

Order As AC68Y (Pac-Man) Price £29.95

Haunted House

For one player using a joystick controller, this cartridge contains four different games. In this exciting game, players must search through a multi-storey, haunted mansion with many, many rooms to find pieces of long-lost treasure and get out again alive. There are giant tarantulas, vampire bats and a ghost to contend with and you need to keep lighting the match to see the objects you need. There are three pieces of a magic urn, a master key to move through doors and a silver cross to keep monsters at bay. And watch out for the secret passage, it could save your life.

Order As AC69A (Haunted House)
Price £18.95

ATARI VIDEO GAME COMING SOON

The following titles are due to be released during the life of this magazine. Full details in our next issue.

AC70M	**From Demons To Diamonds**	**Price £18.95**
AC71N	**Yar's Revenge**	**Price £29.95**
AC72P	**Berzerk**	**Price £29.95**
AC73Q	**Defender**	**Price £29.95**
AC74R	**Adventure I**	**Price £24.95**
AC75S	**Adventure II**	**Price £24.95**
AC76H	**Raiders Of The Lost Ark**	**Price £29.95**

ATARI COMPUTER NEWS *(continued from page 58)*

Coming Soon

Lastly, a few explanations are necessary. Firstly, where is Jumbo Jet Lander and Sub-Commander. You may well ask and I only wish I knew. It appears that both of these products were announced far too early to yourselves, the press and us and I must apologise for the delay, even though it's not our fault. The latest news is that both are now in a playable condition and they are still coming down the pipeline. Those of you who have placed orders will receive your software the minute it is available.
Where are the Tech User Notes? — a question I have been asking for several months. It appears that the Americans are not as inquisitive as us English types and rarely buy the things. Thus Atari were caught with their slacks down! However, with the advent of the U.K. Division of Atari we have negotiated what I feel is an amicable solution and I hope you will agree. All those people waiting for Tech Notes will now receive De Re Atari. Although there is some information in the Tech Notes that is not in De Re Atari, the latter is a far better publication to learn from and offers very good explanations of a player missile graphics, scrolling, display list interrupts, vertical blank interrupts and the section on sounds has to be seen to be believed. I hope this arrangement will be acceptable to the majority of you and anyone who is unhappy at the prospect of receiving the world's most sought after Atari publication will of course be suitably reimbursed. I am still trying to locate Tech User Notes and we will do our best to come up with some news for the next Quarterly.

ATARI PRICE CHANGES

We regret that owing to Atari restructuring their price list after the cover of this magazine was printed, some of the prices on the back cover are incorrect.

Hardware

AF02C	The £599 price is strictly while stocks last, then the price will revert to:	£645
AF08J	64K RAM Module	£65.00
AF28F	Cassette Recorder	£50.00
AF36P	The £299 price is strictly while stocks last, then the price will revert to:	£345
AF41U	Printer Interface for 400	Price £59.95
AF42V	Printer Interface for 800	Price £59.95

Software

YG42V	Word Processor	Price £99.95
YG43W	Invitation To Programming 1	Price £15.95
YG44X	Conversational French	Price £39.95
YG45Y	Conversational German	Price £39.95
YG46A	Conversational Spanish	Price £39.95
YG47B	Conversational Italian	Price £39.95
YG48C	Music Composer	Price £35.95
YG49D	Touch Typing	Price £15.95
YG51F	Graph-It	Price £13.95
YG52G	Statistics	Price £13.95
YG53H	Energy Czar	Price £9.95
YG54J	Hangman	Price £9.95
YG55K	Kingdom	Price £9.95
YG56L	States & Capitals	Price £9.95
YG57M	European Capitals	Price £9.95
YG58N	Scram	Price £17.50
YG59P	Telelink	Price £21.50
YG61R	Basketball	Price £24.50
YG62S	Blackjack	Price £9.95
YG63T	Chess	Price £24.50
YG67X	Super Breakout	Price £24.50
YG68Y	Assembler Editor	Price £39.95
YG69A	Pilot (Consumer)	Price £54.00
YG70M	Space Invaders	Price £29.95

NEW PROGRAMS FOR ATARI AVAILABLE SOON

BQ65V	Personal Financial Management	Price £49.00
BQ66W	Mortgage & Loan	Price £13.95
BQ67X	Invitation To Programming 2	Price £22.95
BQ68Y	Invitation To Programming 3	Price £22.95
BQ69A	Caverns Of Mars	Price £24.50
BQ70M	Centipede	Price £29.95
BQ71N	Pac-Man	Price £29.95
BQ72P	Video Easel	Price £24.50
BQ73Q	Macro Assembler	Price £59.95
BQ74R	Microsoft Basic	Price £59.95
BQ75S	Pilot (Educator)	Price £79.95

More details in our next issue or telephone our sales office.

MAPLIN NEWS

MATINEE ORGAN UPDATE

Following the 2-page section in our last issue we have now found three more possible problems. The page numbers refer to the construction book XH55K.

Page 27/28

24. If you wish the piano to re-trigger when an additional note is played, connect a 1uF 35V tantalum capacitor with its negative lead to the negative end of C179 and its positive lead via a length of wire to the unused pin 13 of IC44. See Figure 13 & 14.

Page 38

25. If your Matinée does not seem loud enough at full volume, change R582 to Min Res 220k. It is advisable only to make this change after all the modifications relating to noise previously described have been made.

26. Some constructors have noticed an audible click or thump when Wah is turned on for the first time. To eliminate this, add two resistors. One, a Min Res 470k should be connected under the pcb between the collector and emitter of TR51. See Figure 15. The second, a Min Res 100k, is connected on the top side of the pcb at S34, between the centre and back pins of the left side of section 'a'. See Figure 16.

Figure 13. Piano re-trigger modification (tantalum end).

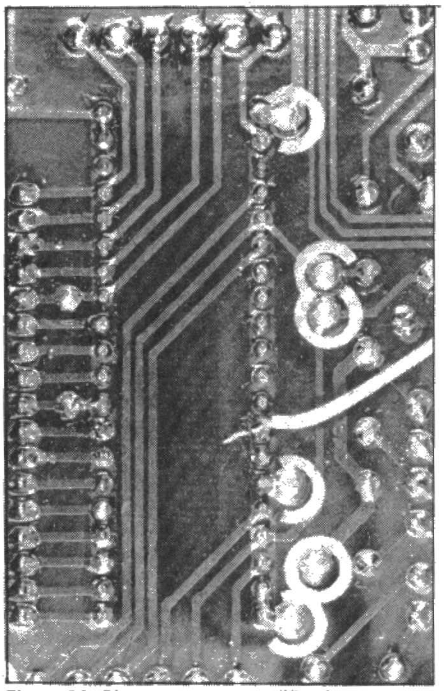


Figure 14. Piano re-trigger modification (M108 end).

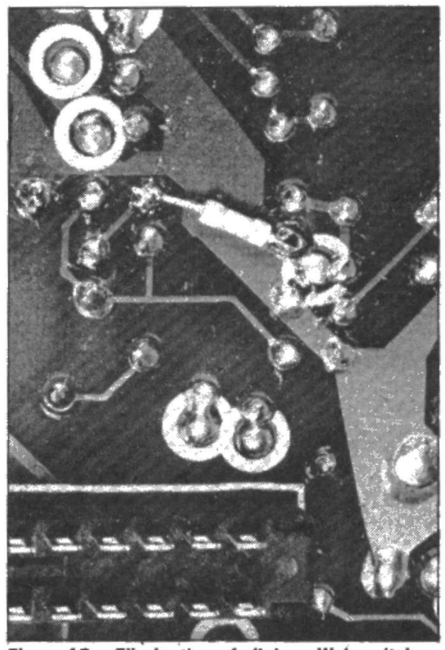


Figure 15. Elimination of click on Wah switch (underside).

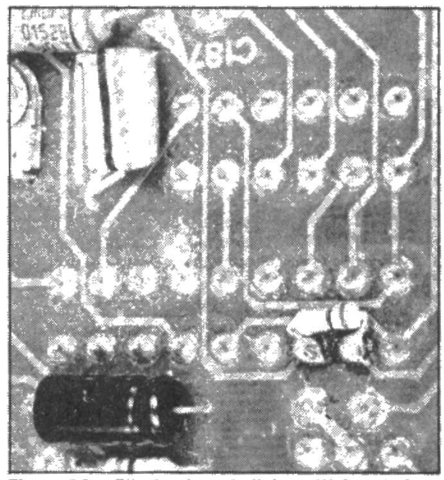


Figure 16. Elimination of click on Wah switch (topside).

QUICK-FIT METERS

Some of the technical details relating to these meters in our last issue were incorrect. The internal resistance of the following meters is as shown below:

10mA DC	5Ω
50mA DC	1.8Ω
100mA DC	0.8Ω
500mA DC	0.5Ω
1A DC	0.3Ω
5A DC	0.2Ω

Our apologies for this error.

TELEPHONE/BURGLAR ALARM CABLE

A high quality cable complying with British Telecom specification CW1293 for use in wiring telephones in customers' premises. It is also ideal for wiring contacts in burglar alarm systems. The cable contains four solid tinned annealed copper conductors each 0.5mm diameter insulated with PVC. Insulation colours are:

a-wire : blue
b-wire : orange
c-wire : green
d-wire : brown

Overall insulation is in cream PVC.
Nominal conductor area : 0.2mm^2
Max working voltage : 80V
Max current per core : 0.25A
Overall diameter : 4mm

Sold per metre (max length in one piece: 250m).

Order As XR66W (4-Wire Phone Cable) Price 15p per metre

MAPLIN CATALOGUE PRICES OVERSEAS

Our current 1981/82 catalogue is available overseas by post at the following prices:

Europe surface mail	£1.68
Europe air mail	£2.75
Outside Europe surface mail	£1.68
Outside Europe air mail (depending on distance)	£3.26/£4.23/£4.88

For surface mail anywhere in the world you may send 12 International Reply Coupons.

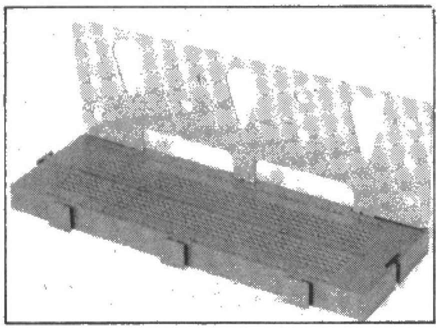
SPECIAL OFFERS

PACK OF 10 C90 CASSETTE TAPES

A good quality, low noise, high energy cassette tape in a library box. The C90 cassette gives 45 minutes recording time on each side. Incredible value. A pack of ten cassettes for only £4.95 including VAT.

Order As SP90X (Pack of 10 C90 Tapes) Price £4.95

— OFFER CLOSES AUGUST 31ST, 1982 —

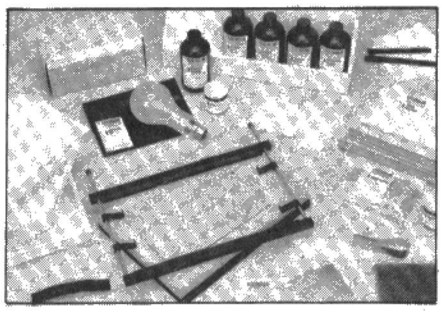


PROFESSIONAL PLUGBLOCK

Our professional plugblock described on page 144 of our current catalogue is offered until August at this big saving. Usual price £6.95. Save £2!

Order As SP91Y (Prof Plugblock) Price £4.95

— OFFER CLOSES AUGUST 31ST 1982 —



MAKE YOUR OWN PCB's KIT CM100

This superb kit contains everything you need to make your own pcb's starting from the artwork printed in the magazine or your own drawing.

Contents List

Special autopositive film
Photoflood bulb
Developer part A
Developer part B
Film fixer
Film clearing solution
3 photographic dishes
Lint-free cloth
2 pairs plastic gloves
Liquid measure
Liquid crystal thermometer
Cotton wool balls
Retouching pen
Film clips
Universal exposure and assembly frame
Photoresist
Applicator holder and foam strip
Photoresist developer concentrate crystals
6 double-sided circuit boards
Bag of copper etchant
Scouring pad
Solder flux/protective lacquer
2 1mm HSS drills
Etchant neutraliser

All the above items will be available separately later so that you can top up your kit.

As an introductory offer you can purchase the kit for £10 off our usual price.

Order As SP92A (CM100 PCB Kit) Price £59.95

INTEREST FREE CREDIT FROM MAPLIN (APR = 0%)

Now you can get 9 months interest free credit on any order containing over £120 worth of computer hardware. Here's how it works.

In our shops:

1. Phone the branch of your choice and give them your order (must include at least £120 worth of computer hardware). We will also have to ask you some personal financial questions in order to fill up our credit application form.
2. We will phone you back within 48 hours to let you know whether your application has been approved.
3. Any time after this, you may visit the shop to collect the goods. You must bring with you some form of identification (e.g. driving licence, credit card) and sign the form that we filled in on your behalf. A deposit of 10% will be required.
4. A further 10% will be payable every month for a further 9 months equalling the total cash price for the goods.

By mail-order

1. Send your order to us (which must include at least £120 worth of computer hardware) and mark clearly on it "Interest Free Credit Terms". Enclose 10% of the value of the goods with your order.
2. We will send you by return of post, a credit application form.
3. Complete the form and post it in the stamped addressed envelope supplied.
4. When approved we immediately despatch your goods to you.
5. One month after goods despatched the first 10% payment becomes due, and thereafter a further 10% is due monthly for a further 8 months, equalling the total cash price for the goods.

Example

A VIC20 computer could be yours for just £19.99 down and £20 per month for nine months.

Don't delay

This incredible offer is only available until 31st August 1982.

MAPLIN RTX DOPPLER UNIT *(continued from page 8)*

DOPPLER MODULE PARTS LIST

Resistors — all ⅓W 5% carbon unless specified		
R1	3k9	
R2	1k (⅛W)	
R3	82k (1%)	
R4	51k (1%)	
R5	150k	
R6	4M7	
R7,17	470R	2 off
R8,11,19	10k	3 off
R9	2k2	
R10	470k	
R12,13	220k	2 off
R14	100k	
R15,16	1k	2 off
R18	220R	
R20	47k	
RV1	470k horiz sub-min preset	
Capacitors		
C1,10	100nF minidisc	2 off
C2,12	100uF 10V pc electrolytic	2 off
C3,6,9	1uF 35V tantalum	3 off
C4,7,8	100nF polycarbonate	3 off
C5	4n7 polycarbonate	
C11	10uF 35V pc electrolytic	
Semiconductors		
D1,2	1N4148	2 off
D3	1N4001	
LED1	Mini LED red	
	Mini LED clip	
TR1,2	BC548	2 off
TR3	BD139	
TR4	BC109C	
TR5	BD131	
IC1	TL430C	
IC2	uA 741C (8-pin)	
IC3	LF353	
X1	Radar module	
Miscellaneous		
	Doppler PCB	
	Veropin 2141	8 off
	Box AB7	
	Grommet small	
	Label Maplin RTX3	
	Countersunk bolt 6BA ½in	4 off
	Countersunk bolt 6BA 1in	2 off
	Washer 6BA	10 off
	Nut 6BA	10 off
	Hook-up wire	½m

See page 61 for details of interconnecting wire suitable for burglar alarms.

A complete kit is available of all the above items plus an application form for the required licence.

Order As LW73Q (RTX3 Doppler Kit) Price £39.95

AMENDMENTS TO CATALOGUE

Please amend your 1981 catalogue as follows:

Page 17/18
BW46A, 47B and 48C are replaced by the UP1300/W which is a wideband amp covering the whole UHF band. The new amp gives a typical gain of 13dB and a much improved noise figure of typically 2.5dB.
BW49D is replaced by the UP1300/V which has a typical gain of 19dB and a 2.5dB noise figure.
BW50E is replaced by the PU1240 which is electrically the same as the PU102, but is in a box like YQ22Y and has co-ax sockets for both sides of the aerial lead, instead of screw terminals, making connection simpler.

Page 20
Telescopic Aerial (LB10L) now only 4ft long and slightly thicker at base.

Page 22
Mains adaptor (YB22Y) and (XX09K) are now the same item and should be ordered as (XX09K). This new adaptor will deliver 300mA max and may be switched to any of the following voltages: 3V, 4.5V, 6V, 7.5V, 9V and 12V DC.

Page 47
XY17T and XY18U are now being supplied in a smaller size. New size is 33 x 12in. (835 x 305mm).

Page 70
Electric pump XY74R is now supplied complete with a pressure gauge.
Suppressor capacitor HW02C is 1uF.

Page 93
Stereo headphone (LH85G) is now styled slightly differently from the one shown in the catalogue.

Page 104
5A Plug (HL57M) is bakelite and not nylon.

Page 107
Touch Dimmer (FQ14Q) is 250W (not 630W).

Page 115
Order codes for Slotted Nuts are WL43W (Collet Rd Nut ⅜in) and WL44X (Collet Rd Nut 10mm).
RX38R, Ebonite Rod is now being supplied in nylon.

Page 120
The DM1500D microphone is now supplied without a jack plug connected to the 5m lead.

Page 133
1mm light guide (XR56L) now being supplied with black protective sheath. Overall dia. 2.2mm.

Page 137
The spacesound units are now being supplied in slightly different sizes.

Page 154
BB67X (3600 VCF Mtg Bkt) should be included in the list under the heading "Mounting Brackets".

Page 177
The belt-drive turntable XB25C is now being supplied without an on/off switch making it suitable only for use in disco's etc.

Page 182
Please note picture of stylus 29 is incorrect. The shaft is round not square. The picture of stylus 31 is also incorrect.

Page 184
Musicentre kit C113 (LX03D) is supplied with one bottle of fluid only.

Page 186
Cassette Splicer (YW90X) is now being supplied with one reel of splicing tape.

Page 201
QH55K (MJE2955) is now being supplied as TIP2955 and QH56L (MJE3055) as TIP3055. Please note V_{CBO} is now 100V, V_{EBO} is now 7V, I_C (max) is now 15A, and the pin-out is now style P3c.

Page 229
In suggested PSU for LM383, the top end of the Std Res 100R should be connected to the collector of Q1 NOT the emitter.

Page 232
The pin-outs for the NE571 and TDA3410 are swapped over.

Page 235
The delay given by the TDA1022 is between 512us and 51.2ms and not as stated in line 2.

Page 243
In Parts List C11 is BX11M price 9p.

Page 245
The IC pin numbers in the right-hand drawing under the heading LM3911 are incorrect. The left-hand drawing is correct.

Page 255
The pin numbers on the IC package drawing under the heading L200 are in reverse order. They should be in sequence with 5 at the top and 1 at the bottom.

Page 258
QQ04E 6402 UART is now being supplied coded CDP1854ACE. These two parts are identical.

Page 266
Small Thermpath (HQ00A) is now supplied in 10g tubs.

Page 270
Crossover 2-Way (WF02C) is now physically slightly different, but it is electrically identical.

Page 276
Dual rocker neon (YR70M) requires a panel cut-out 29 x 22mm.

Page 282
Footswitch (LB64U) is supplied with a 2.5mm plug fitted to the lead.

Page 299
Crimp tool (FY31J) is improved with an additional 1mm stripper and crimpers for 1.5, 2.5, 4 and 6mm press terminals.

Page 301
Needle file set (YW63T) now contains only 10 files; there is one flat warding and one hand file, not two of each.

Page 319
The alphabetical order under S is incorrect. "Semiconductor Finder" should come after "Self-Tappers" and "Stand-offs" after "SRBP".

CORRIGENDA

The following errors in previous issues have come to our attention since the last issue was published. We offer our sincere apologies for any inconvenience caused.

Issue 1	
Page 3	In Figure 1, R70, a Min Res 100k should be shown between the wiper of RV13 and IC12 pin 3/C38.
Page 4/5	The pcb legend and Figure 7 are incorrect. The resistor marked R33 that is next to R32 should be R31. And the resistor marked R25 that is next to R27 should be R26.
Issue 2	
Page 7	On the Common pcb legend, the link next to R15 has been omitted.
Page 9	In Figure 10b, all the transistors shown, should be mounted with the metal insert upwards.
Page 12	In the Common/PSU parts list, R17 should be a Min Res 100k. This error also occurs in Figure 2 on page 4.
Page 18	In Figure 2 the battery connections should be red wire to S5, black wire to pin 2.
Pages 41/44/47	If the external horn is not loud enough make R5 on the External Horn pcb and R9 on the Main pcb into links.
Page 47	In the Main parts list, R30 should be a Min Res 100k. This error also occurs in Figure 1 on page 39.

MPG METER: FURTHER NOTES

One or two constructors have written to us to ask for further explanation of the setting-up procedures for this project. Here, Mike Wharton explains in more detail.

Introduction

The basis of the MPG meter is to take two signals, one for fuel flow and one for speed or distance, and produce from them a digital display of 'miles per gallon'. In order to accommodate a wide variety of vehicles, the design includes a variable scaling factor. This is calculated for a particular vehicle and then set using links B1 to B8.

Calibration

To ensure that the display gives a true reading of mpg, it is obviously important that the scaling factor is correctly set and the article may not have made it entirely clear how this is achieved. The equation for calculating the factor 'n' is:—

$$\frac{8.5 \times 3000}{X \times Y} = n$$

The values which need to be known first are thus X and Y. The value of X is the division ratio of IC6, and is set by making only one of the links A1 to A7, each having the value shown in the table.

The value of '8' referred to in the article (p55) would thus be obtained by connecting Link A4.

The value of 'Y' can be obtained in one of two ways, either from the vehicle manufacturers as the number of turns of the speedo cable per mile travelled, or by using the method explained in connection with Figure 5 of the article. If the "turns per mile" figure is known then an appropriate value of Y for the formula is:—

$$Y = \frac{\text{(Turns per mile)}}{12}$$

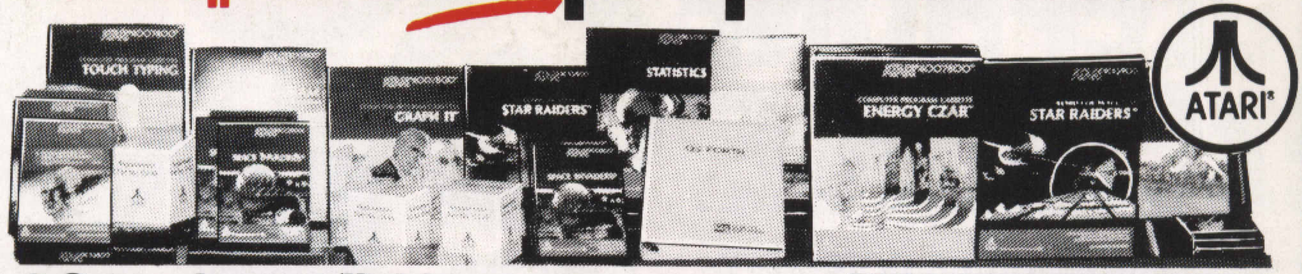
If the value of 'Y' is to be found using the meter itself, then Link A or IC6 is first omitted and Link B1 made temporarily. This will enable the required value of 'Y' to be found according to the method described in the article.

To complete the calibration, the value of 'X' may be chosen and then 'n' calculated. This is then set, as explained in the article, using Links B1-B8 (remembering to remove B1 if it is not needed).

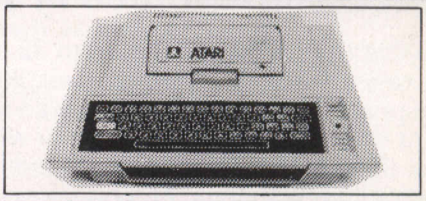
Naturally, changing the chosen value of 'X' will not affect the value of 'Y' (only changing the gearbox or back-axle will do that!) but will involve a re-calculation of 'n' and hence a resetting of Links B1 to B8).

Link	Value of 'X'
A1	1
A2	2
A3	4
A4	8
A5	16
A6	32
A7	64

MAPLIN the people for Atari



3 Consoles available:



Atari 400 with 16K RAM(AF36P) £299
Atari 400 with 32K RAM(AF37S)£395
Atari 800 with 16K RAM (AF02C) £599

Lots of other hardware:

Cassette Recorder	(AF28F)	£55.00
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